J. WEATHERBY.

ORE CONCENTRATOR.

APPLICATION FILED OCT. 6, 1913.

1,145,046.

Patented July 6, 1915.

5 SHEETS—SHEET 1.

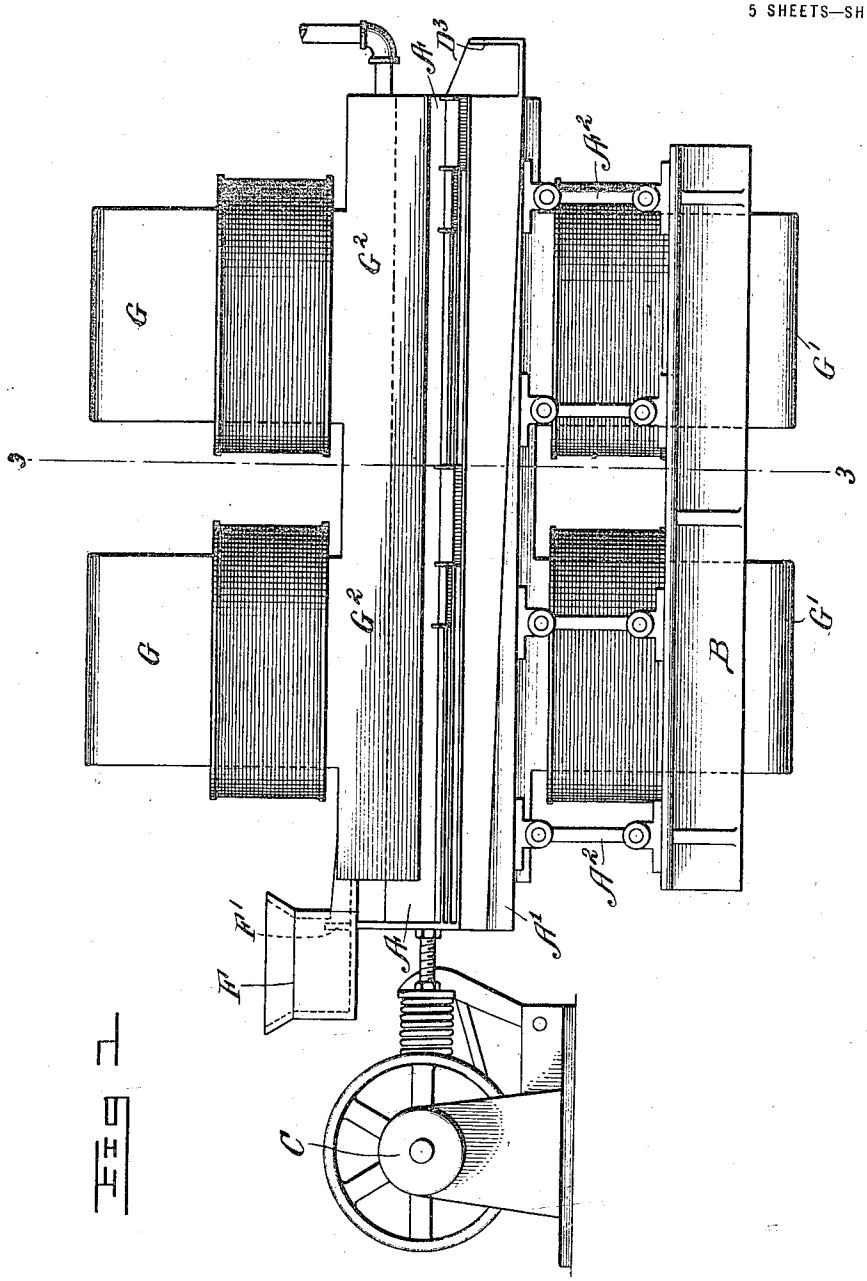


Fig. 1.

Witnesses
Halbert Brown.
M. G. Crandell

Inventor
Joseph Weatherby
By Church & Church
his Attorneys

J. WEATHERBY.

ORE CONCENTRATOR.

APPLICATION FILED OCT. 6, 1913.

1,145,046.

Patented July 6, 1915.

5 SHEETS—SHEET 2.

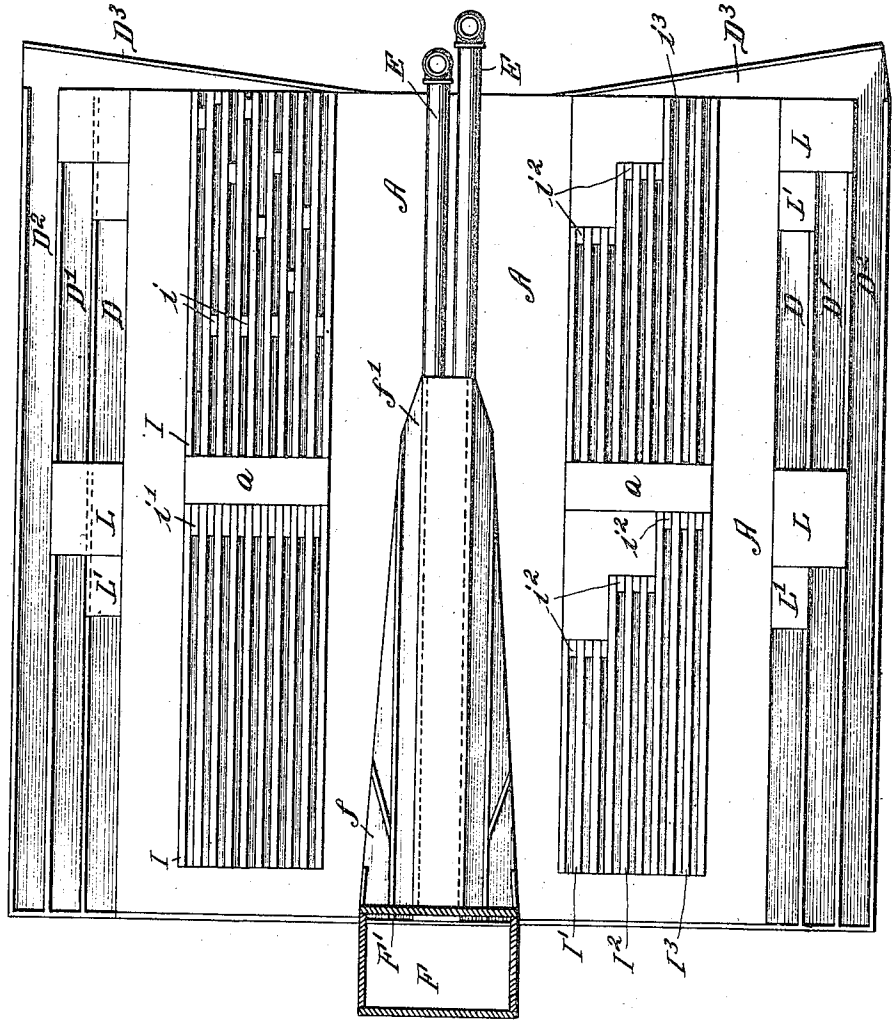


Fig. 2.

Witnesses

Halbert Brown.

M. B. Crandell

Inventor

Joseph Weatherby

By Church & Church

his Attorneys.

J. WEATHERBY.

ORE CONCENTRATOR.

APPLICATION FILED OCT. 6, 1913.

1,145,046.

Patented July 6, 1915.

5 SHEETS—SHEET 3.

Fig 3

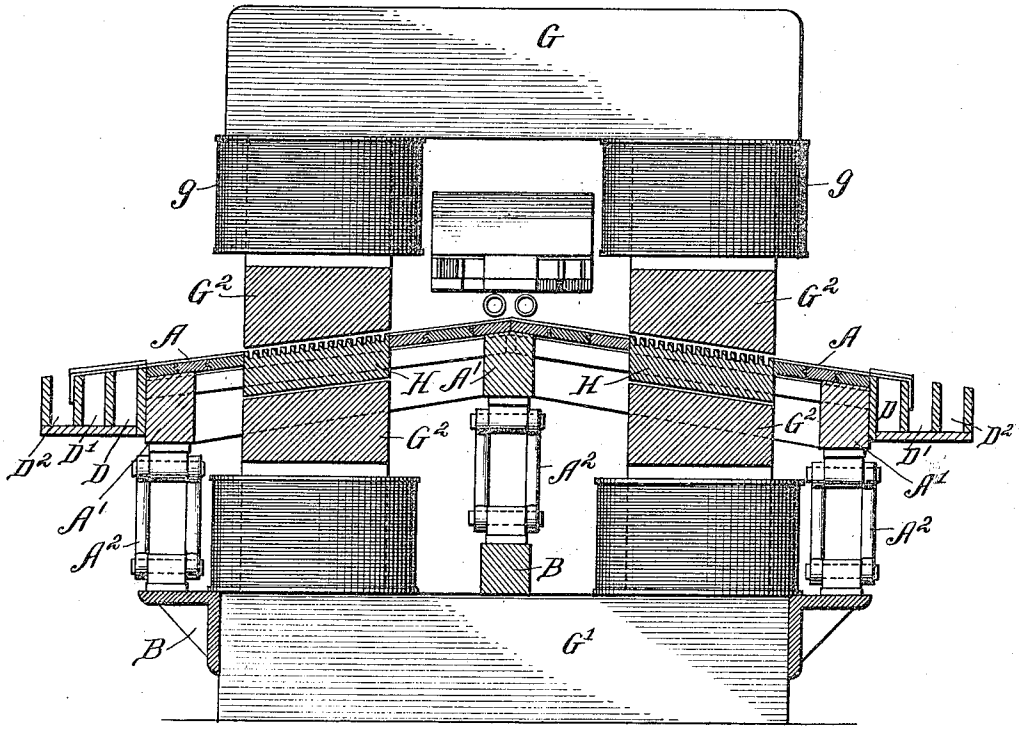
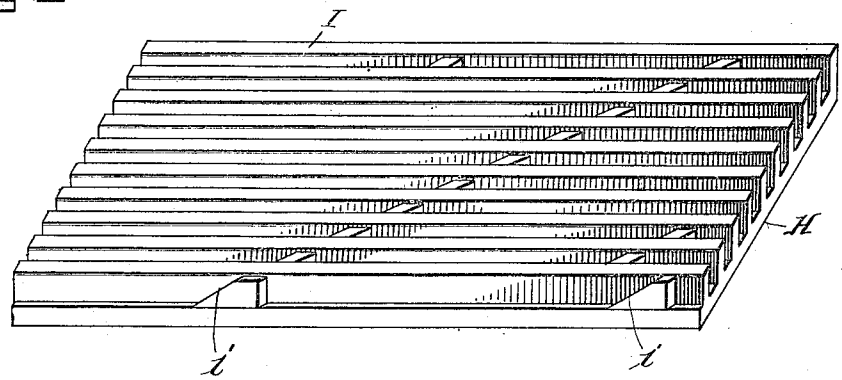


Fig 4



Witnesses

Halbert Brown.

M. G. Crandell

Inventor

Joseph Weatherby

By Church & Church

Its Attorneys

J. WEATHERBY.

ORE CONCENTRATOR.

APPLICATION FILED OCT. 6, 1913.

1,145,046. Patented July 6, 1915.

5 SHEETS—SHEET 4.

Fig 5

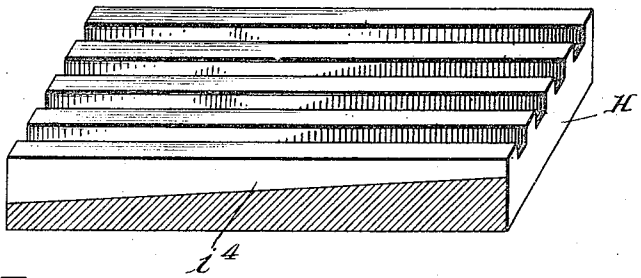
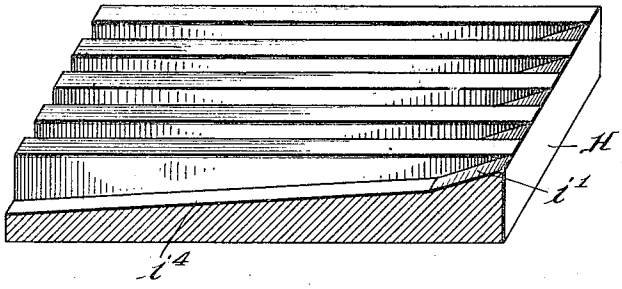


Fig 6



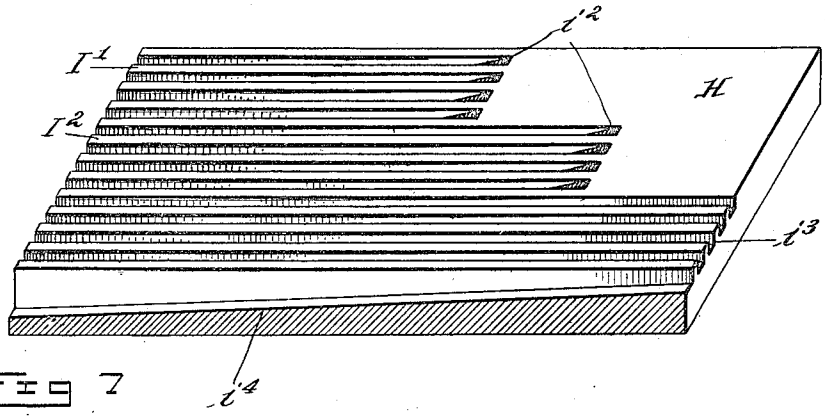


Fig 7

Witnesses

Halbert Brown.

M. G. Crandell

Inventor

Joseph Weatherby

By Church & Church

Their Attorneys.

J. WEATHERBY.

ORE CONCENTRATOR.

APPLICATION FILED OCT. 6, 1913.

1,145,046.

Patented July 6, 1915.

5 SHEETS—SHEET 5.

Fig 8

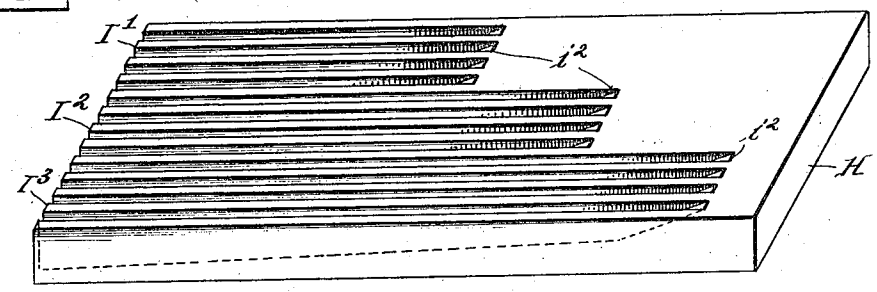


Fig 9

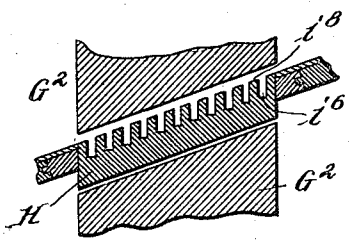


Fig 10

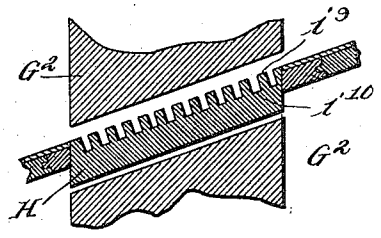


Fig 11

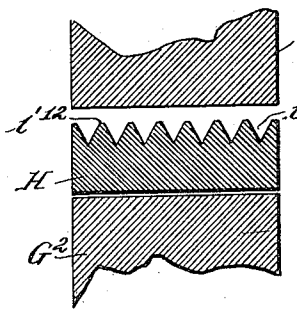


Fig 12

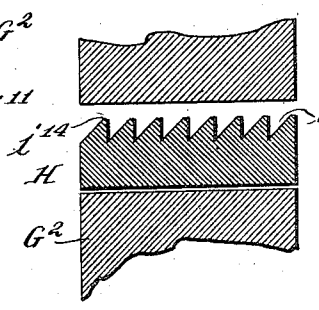
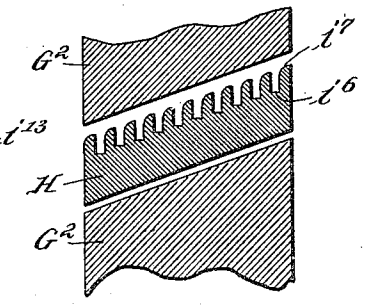


Fig 13



Inventor

Joseph Weatherby

By Church & Church

Their Attorneys.

Witnesses

Halbert Brown.

M. G. Crandell

UNITED STATES PATENT OFFICE.

JOSEPH WEATHERBY, OF NEW CUMBERLAND, PENNSYLVANIA, ASSIGNOR TO ELECTRIC ORE SEPARATOR COMPANY, OF NEW CUMBERLAND, PENNSYLVANIA, A CORPORATION OF DELAWARE.

ORE-CONCENTRATOR.

1,145,046. Specification of Letters Patent. Patented July 6, 1915.

Application filed October 6, 1913. Serial No. 793,700.

To all whom it may concern:

Be it known that I, JOSEPH WEATHERBY, a citizen of the United States, residing at New Cumberland, in the county of Cumberland and State of Pennsylvania, have invented certain new and useful Improvements in Ore-Concentrators; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, and to the figures and letters of reference marked thereon.

This invention relates to ore concentrators, being particularly, though not exclusively, adapted to pulsating or shaking tables, especially of the type referred to in my prior Patent No. 1,071,975, granted September 2, 1913, and designed to effectually separate ore mixtures having such slight difference in specific gravity as precludes their separation by the ordinary process.

The objects of the invention are to simplify and improve the structure of the concentrator, increase its capacity, make a more effectual separation of the ore mixtures possible, and provide means whereby a series of different grades of material may result, or materials having a series of different characteristics, may be separated by a single operation.

Another object of the invention is to provide means whereby portions of the mixture will be automatically subjected to a re-washing process or succession of re-washing processes, for the purpose of separating therefrom ingredients which may have been entangled therewith or mechanically held against separation at a previous stage of the process.

Referring to the accompanying drawings,—Figure 1 is a side elevation of an ore concentrator embodying the present improvements, well known parts being omitted or indicated in general outline only. Fig. 2 is a top plan view of the table or deck, together with the pulp feed box and wash water pipes, the top magnets being entirely omitted. Fig. 3 is a transverse section, substantially in the plane indicated by the line 3—3 in Fig. 1, looking toward the left or head motion end of the apparatus; Fig. 4 is a perspective view of a fragment of the table showing one arrangement of means for elevating the material traversing the grooves between the riffle bars; Figs. 5, 6, 7 and 8 are views corresponding to Fig. 4, but showing slightly different arrangements of the riffles. Figs. 9, 10, 11, 12 and 13 are cross sectional views more or less diagrammatic in character, illustrating different forms of riffle bars and grooves in cross section, any of said forms being adapted for use in connection with the constructions shown in Figs. 1 to 8, inclusive.

Like letters of reference in the several figures indicate the same parts.

The type of machine adopted for illustrating the present invention is one embodying a double deck or table, that is to say, one in which the ore mixture and wash water are fed along a central line and flow in divergent directions from said central line, thus increasing the capacity of the table and permitting of an economical and advantageous arrangement of the magnetic fields and circuits.

The table or deck is indicated generally by the letter A and from Fig. 3 it will be seen that it inclines in opposite directions from a center line and is supported upon suitable longitudinal bearers A' which are in turn carried by links A^2 suitably mounted on a base frame B whereby the whole table or deck may be reciprocated in a substantially horizontal plane. For imparting the usual reciprocatory movements a head motion C is connected with the frame of the table at one end, as is common in the art at this day. Along each edge of the table is a series of troughs D, D', D^2, adapted to receive the separated materials flowing down over the edge of the table in a manner which will be presently described, one of said troughs being extended around the discharge end of the table as at D^3 to catch material flowing from the end of the table remote from the head motion end.

Wash water is supplied to the table from wash water pipes E, each pipe preferably embodying means whereby the water supplied to its side of the table may be regulated independently of the other side and the pulp or ore mixture to be separated is fed to the table from a hopper F mounted on one end of the table and communicating

with discharge troughs f and f' leading to different points in the length of the table on each side of the center line. In the preferred construction the ore mixture is prevented from flowing freely into the troughs by a dam or partition F′ over the upper edge of which the mixture is caused to spill by the reciprocatory movements of the table and hopper. With this arrangement it is possible to regulate the feed very accurately by blocking off certain portions or all of the dam or wall where the mixture feeds to the troughs.

In each side of the table there is a riffled area formed by a series of riffle bars having grooves between them and extending transversely of the plane of major inclination of the table, as will be readily understood from an inspection of Fig. 3 where the riffle bars and grooves are shown in cross section and from Fig. 2, where they are shown in top plan. The riffle bars are of magnetic material and when the apparatus is in operation they are made highly magnetic, whereby the upper edge or edges of each riffle bar becomes a magnetic terminal, and the magnetic field is concentrated to a very high degree with the lines of force converging to the edges of the bars. This general principle is set forth in my prior patent before referred to, but in the present invention, the construction and arrangement of the riffle bars and grooves between the same, as well as the field magnets, whereby the intense magnetic fields are created, differ from the arrangement illustrated in said prior patent. In the present instance the double deck arrangement of the table permits of the formation of a perfect magnetic circuit with a maximum economy and convenience of arrangement and with the least possible tendency to distort the table itself or interfere with its mechanical movements.

Field magnets G and G′ are located above and below the table, such magnets preferably having four windings g for each magnet and elongated pole pieces G^2 above and below the portion of the table having the riffle bars and grooves therein. Each magnet is therefore in the form of a multiple horse-shoe magnet, and the pole pieces which are brought into proximity to the upper and lower surfaces of the table have their faces inclined to correspond to the inclination of the table, the effect being to produce a very uniform magnetic circuit with the lines of force uniformly distributed in the gaps in which the table is located.

The magnetic riffles or riffle bars may be of laminated construction as in said former patent, but are preferably formed by milling out the grooves in the upper side of plates H that they may be incorporated in the table structure in such manner that their alinement and position will be maintained in spite of the traction exerted by the field magnets.

By reference to Fig. 2, it will be seen that the magnetic riffle bars in the particular machine adopted for illustrating the invention are arranged in four groups, two on each side of the table and each group is adapted to receive the discharge from one of the feed troughs f, f'. Between the sets of riffle bars on each side of the table there is a blank space a which serves to separate the sets of riffle bars and insures the movement of gangue from the first set transversely of the table before it can reach the second set, and the several sets of riffles will therefore act practically independently of each other, but are all adjusted and operated simultaneously so as to give, if desired, corresponding uniform results. In some instances, however, owing to the character of the product sought to be produced it is desirable to make the riffle bars in each set differ from the other in their relative arrangement. As shown at the upper side of Fig. 2 the riffle bars I of the two sets are all practically of full length, one of said sets, however, being provided at various intermediate points with gangue elevating inclines i to be presently described in detail, and the other of said sets being provided only at the ends with gangue elevating inclines i'. At the bottom of Fig. 2 the sets of riffle bars are of differential length; that is to say, each set is composed of relatively short bars I′, bars I^2 of intermediate length, and long bars I^3. All of the bars may be provided with gangue elevating inclines i^2, or, if desired, longer bars of the set remote from the head motion end or at the discharge end of the table may extend out to the edge of the table, as at i^3, where the material will be caught in the end trough D^3.

The arrangement and construction of the riffle bars and grooves between the same will be better understood from an inspection of Figs. 4 to 8, inclusive; thus, in Fig. 4 it will be seen that between each of the riffle bars I and at suitable succeeding distances from the end the grooves are provided with inclined ore supporting surfaces i, which serve to elevate the material progressing along in said grooves up to approximately the plane of the terminal edges of the bars, where such material will be washed over into lower grooves and any susceptible material which has been entangled therewith will be supported by the magnetic edges and magnetic bridges between the riffle bars, and will flow with the water transversely of the grooves while the gangue will drop into the grooves and be progressed to their discharge end.

In Figs. 5, 6 and 7 it will be seen that the grooves are provided with long inclined ore

supporting surfaces i^4 which incline upwardly toward the discharge end, and this incline may be continued to gradually elevate the material traveling in the grooves until it is all, or the desired portion of it, elevated into the plane of the edges of the riffle bars, or the relatively sharp inclines i' may be employed for elevating the material when traveling a relatively short distance longitudinally of the grooves. As shown in Figs. 7 and 8, the inclines i^2 at the ends of the bars I′ and I² are of the character shown at i' in Fig. 6, while the lowermost grooves of the set open out at the ends, as at i^3 where the grooves are of much reduced depth and if they are full of material the upper portion of the material will be elevated to the level of the edges of the riffle bars. The construction shown in perspective in Fig. 7 corresponds to the set of riffles in the lower right hand corner of Fig. 2, and the construction shown in Fig. 8 corresponds to that shown in the lower left hand corner of Fig. 2.

The shape in cross section of the riffle bars and grooves between the same, it is obvious may be variously modified without departing from the invention, and some modification may be desirable in operating on certain classes of material. The preferred form of riffle bars and grooves is that shown in Fig. 13, which figure, together with Figs. 9 and 10, shows a table or deck in which riffled areas are inclined at rather an accentuated angle, this being done in order to accentuate the illustration of the forms of the bars and grooves. In Fig. 13, which illustrates the preferred construction, the riffle bars project vertically, or at an acute angle to the angle of inclination of the deck or table, and the bottom or ore supporting surfaces i^6 of the groove are horizontal in cross section, this construction giving the greatest capacity for gangue material in the groove with the greatest freedom of movement longitudinally of the groove under the influence of the table movements. In this construction also the upper edges of the riffle bars on the lower side are rounded off or formed at a greater inclination than the table, as at i^7, whereby the greatest concentration of the lines of magnetic force will be to the upper edges, and susceptible material, when moved transversely away from said upper edges by the force of the water, will slide over the surface of the riffle bars into a portion of the field which is less concentrated, and will be immediately carried across the groove supported as it were on the magnetic bridge having its lines of concentration to the upper edge of the next riffle bar. This detail of construction permits of an increase in the rapidity with which the apparatus may be operated or the quantity of material operated on in a given time, and for this reason it is preferred, but effective and for some materials better arrangements are as indicated in Figs. 9 and 10; thus, in Fig. 9 the grooves substantially correspond to the grooves in Fig. 13, but the upper edges of the riffle bars are cut at an angle which substantially corresponds to the angle of inclination of the deck or table, as shown at i^8 in said Fig. 9. In Fig. 10 the riffle bars and grooves are at right angles to the plane of the deck or table, and, therefore, the upper edges i^9 of the riffle bars and the bottom or supporting surfaces i^{10} of the grooves are parallel with the plane of the deck or table. In Fig. 11, the grooves i^{11} are of V-shape, while the riffle bars taper upwardly and have narrow flat upper edges i^{12}. In Fig. 12, the grooves have one incline and one straight face, as at i^{13}, while the bars have narrow flat upper edges or faces at i^{14}.

In order to conduct certain of the separated materials from the edge of the table across the troughs D and D′ movable extensions of the table are provided which form in effect bridges or chutes which will deposit the material flowing onto or through the same in the outer trough or troughs, as the case may be. These movable extensions or bridges are indicated in Fig. 2 at L and L′, and it will be understood that they may be shifted longitudinally of the troughs to take the proper grade of material and conduct the same into the desired trough.

In the operation of the apparatus it is designed that the inner trough D shall receive the concentrate, the middle trough middlings and the outer trough gangue material. With this in mind, the operation of the apparatus will be quite apparent to those skilled in the art, for the ore mixture fed to the upper portion of the deck or table will be distributed to the riffled areas in the well known way and, as explained in the patent before referred to, the material flowing across these areas will be separated both by reason of the difference in specific gravity of the different ingredients and by reason of the difference in magnetic susceptibility, the more susceptible material being supported by the magnetic bridges as it were, whereby it will flow transversely of the riffles. The concentration of the lines of magnetic force to the magnetic terminals or riffle edges serves to effectually prevent the more susceptible material from dropping down into the grooves, while the less susceptible material drops into the grooves and is progressed longitudinally of the same by the mechanical action of the table.

In the practical operation of the apparatus it is found that when worked to its capacity, which seems to be limited only by the capacity of the grooves to carry off the gangue material, there is a tendency of the

gangue material to entangle and carry down with it against the action of the magnetic field, a small percentage of the more susceptible material, and having once been forced down into the grooves such material is liable to be progressed and discharged with the gangue. The present invention, however, provides a means whereby this material is effectually recovered, inasmuch as the gangue material is elevated out of the grooves and into the plane of the magnetic terminals during its progress along the grooves and when it is still in position to be dropped into other grooves and progressed to the proper point of discharge. This elevation of the gangue material with any of the more susceptible material gives the mixture what might be termed a rewashing, and leaves the more susceptible material supported in the magnetic field, for it will inevitably be moved into contact with the magnetic terminals and will thereafter be supported above the grooves in position to flow or travel transversely of the riffles.

Referring particularly to the lower portion of Fig. 2 of the drawings, it will be seen that any gangue material traveling along the grooves in the portion I′ of the riffled area will be elevated out of the grooves at a point where it will be deposited in the grooves of the portion I^2, and the material traveling in the grooves of the portion I^2 will be elevated at a point where it will be deposited in the grooves of the portion I^3. The material traveling in the grooves I^3 will be elevated to the plane of the table surface and will flow off as gangue material down over the extension L into the outer or gangue trough D^2. The middlings, it is found, will flow in a zone which is substantially coincident with the narrower bridge or extension L′ and will be conducted by it into the middlings trough D′, while the concentrate will be deposited in the concentrate trough D in a zone which is to the left of the bridge or table extension L′ in Fig. 2.

The table is preferably given a slight inclination from the head motion end upwardly toward the gangue discharge end, thus producing a tendency of the water to flow from the gangue discharge end toward the ore feed end, or in a measure in opposition to the direction in which the gangue travels by reason of the table movement.

It is obvious from the foregoing that the inclined ore supporting surfaces in the grooves may be variously arranged without departing from the present invention, and in some instances it is found desirable to form the grooves and bars by milling plates of magnetic metal from end to end, and inserting filling pieces with inclined faces thereon, as shown, for example, in Fig. 4, where the inclined surfaces are on filling blocks which are inserted in the grooves at appropriate points.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. An ore concentrator embodying a table on which stratification and separation is effected, riffle bars having magnetic terminal edges mounted in the table, with grooves between said bars having ore supporting surfaces therein inclined to elevate the ore traveling in the grooves, up to the plane of the terminal edges of the bars.

2. An ore concentrator embodying a table on which stratification and separation is effected, riffle bars mounted in the table and having magnetic terminal edges, with grooves between said bars having ore supporting surfaces inclined upwardly to elevate the ore traveling in the grooves up to the plane of said terminal edges, the inclined surfaces in different grooves terminating at different distances from the discharge edge of the table, whereby ore elevated out of one groove will be deposited in another at a point nearer the discharge edge.

3. An ore concentrator embodying an inclined table on which stratification and separation is effected, riffle bars on the table extending at an angle to the plane of inclination of the table, with grooves between said bars having ore supporting surfaces inclined upwardy in the direction of travel of the material in said grooves to elevate the ore up to the plane of the top of the bars, whereby the ore so elevated will be deposited in a succeeding groove in the direction of the inclination of the table.

4. An ore concentrator embodying a table on which stratification and separation is effected, riffle bars having magnetic terminal edges mounted in the table, with grooves between said bars arranged in groups of different lengths with means for elevating the ore traveling in the grooves of shorter length, whereby it will be deposited in the grooves of greater length.

5. An ore concentrator embodying a table on which stratification and separation is effected, and riffle bars mounted therein and spaced to form intermediate grooves, said grooves having bottom ore supporting surfaces inclined upwardly toward the discharge ends of the grooves, whereby the ore traveling in the grooves will be elevated into the plane of the edge of the bars, and means for creating a magnetic field with the lines of magnetic force converging to the edges of the bars, substantially as described.

6. An ore concentrator embodying a table on which stratification and separation is effected, riffle bars having magnetic terminal

edges mounted in the table, with grooves between said bars having their bottom ore supporting surfaces inclined upwardly toward the discharge ends of the grooves at a relatively slight angle, the terminal portions of said ore supporting surfaces being inclined upwardly at a relatively sharp angle whereby the ore traveling in the grooves will be gradually elevated as it progresses and finally lifted into the plane of the magnetic edges of the bars by the abruptly inclined portions of the surfaces.

7. An ore concentrator embodying a table on which stratification and separation is effected, riffle bars of magnetic material mounted in the table with grooves between said bars having ore supporting surfaces inclined upwardly toward the discharge end to elevate the ore into the plane of the edges of the bars, said bars and grooves being arranged in groups of different lengths with the bars and grooves of shortest length remote from the discharge edge of the table and the bars and grooves of greatest length in proximity to the discharge edge of the table, whereby material discharged from the grooves of one group will travel into the grooves of another group in its progress toward the discharge.

8. In an ore concentrator, the combination with means for creating a magnetic field embodying top and bottom field magnets, each having two elongated pole pieces of opposite polarity, the pole pieces of the top and bottom magnets being arranged opposite to each other, whereby intense magnetic fields are created between them, of a reciprocatory table on which stratification and separation is effected mounted in the magnetic field between each of the opposed pole pieces said table embodying riffle bars of magnetic material with terminal edges to which the lines of magnetic force converge, and means for reciprocating said table, and means for feeding ore to be separated to the table between the pole pieces of the top magnet and means near the outer sides of said sole pieces for receiving the separated ore.

9. In an ore concentrator wherein separation and concentration is effected in a dense magnetic field, an ore supporting and separating surface embodying riffle bars of magnetic material having their upper edges rounded on the side toward which the ore travels across said edges, whereby the ore travels through a field of decreasing density over each bar.

10. In an ore concentrator, the combination with a magnet having a pole piece with an inclined under face, of an inclined ore supporting and separating table in proximity to the under face of the pole piece, said table embodying riffle bars of magnetic material with grooves therebetween, each of said bars being formed with its upper ore supporting edge face inclined at a greater angle than the inclination of the face of the pole piece, whereby ore supported by the riffle bar edges will travel across the same through a field of decreasing magnetic density.

11. In an ore concentrator, the combination with a magnet having a pole piece with an inclined under face, of an inclined ore supporting and separating table in proximity to the under face of the pole piece, said table embodying riffle bars of magnetic material with grooves therebetween, each of said bars being formed with its upper ore supporting edge face rounded at a greater inclination than that of the face of the pole piece, whereby ore supported by each riffle bar edge will travel across the same through a field of decreasing magnetic density.

12. In an ore concentrator, the combination of an inclined table on which separation and stratification of the ore mixture is effected, means for creating a magnetic field in the path of the mixture, the material of greater magnetic permeability being supported in the effective area of the magnetic field, and means for successively bringing the material of lesser magnetic permeability into and out of the effective area of the magnetic field in lines deviating from the direction of normal gravital flow, to divide the ore mixture into grades whose characteristics are different degrees of magnetic permeability.

13. In an ore concentrator, the combination of an inclined table on which separation and stratification of the ore mixture is effected, means for creating a magnetic field, portions of the table lying within the effective area of the magnetic field, the material of greater magnetic permeability being supported in the effective area of the field, and means for causing the material of lesser magnetic permeability to travel successively over said portions in lines deviating from the direction of normal gravital flow to bring said material into and out of the effective area of the magnetic field and divide the ore mixture into grades whose characteristics are different degrees of magnetic permeability.

14. In an ore concentrator, the combination of an inclined reciprocatory table on which separation and stratification of the ore mixture is effected, means for creating a magnetic field on the table, whereby the material of greater magnetic permeability is supported in the effective area of the field and advanced in a direction substantially transverse to the general direction of reciprocation of the table, the material of lesser

magnetic permeability moving substantially in the direction of reciprocation of the table, and means for successively bringing the material of lesser magnetic permeability into and out of the effective area of the magnetic field in lines deviating from the direction of normal gravital flow, whereby continued operation of the concentrator acts to divide the ore mixture into grades whose characteristics are different degrees of magnetic permeability, substantially as described.

JOSEPH WEATHERBY.

Witnesses:
ELWOOD D. C. ROSS,
G. P. YETTER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."