W. D. LUDWICK.

MAGNETIC ORE SEPARATOR.

APPLICATION FILED SEPT. 22, 1906. RENEWED MAY 20, 1909.

939,523. Patented Nov. 9, 1909.

3 SHEETS—SHEET 1.

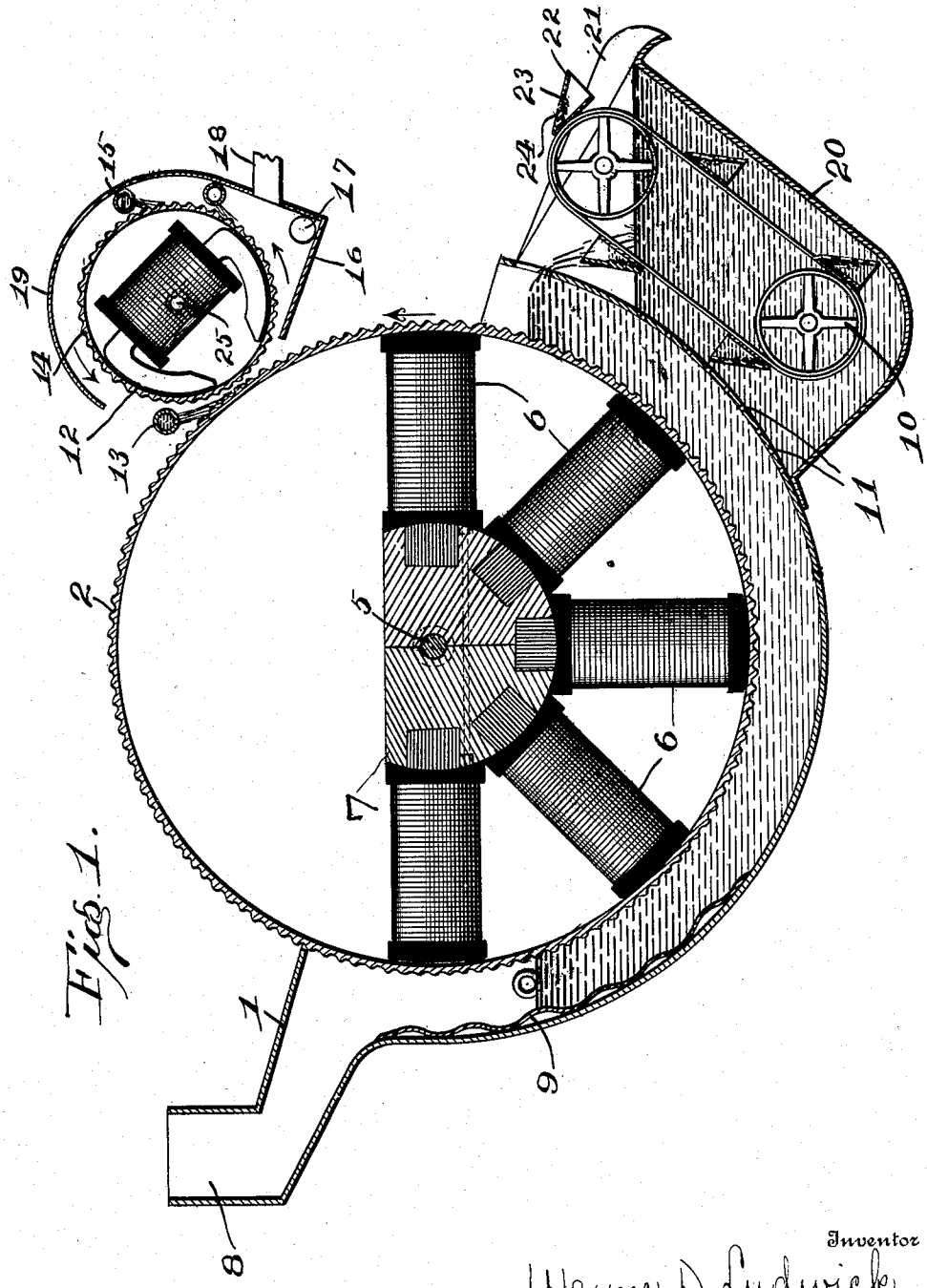


Fig. 1.

Witnesses

W. C. Izel.

A. S. Kitchin

Inventor

Wayne D. Ludwick.

By Mason, Fenwick & Lawrence

his Attorneys

W. D. LUDWICK.

MAGNETIC ORE SEPARATOR.

APPLICATION FILED SEPT. 22, 1906. RENEWED MAY 20, 1909.

939,523. **Patented Nov. 9, 1909.**

3 SHEETS—SHEET 2.

Fig. 2.

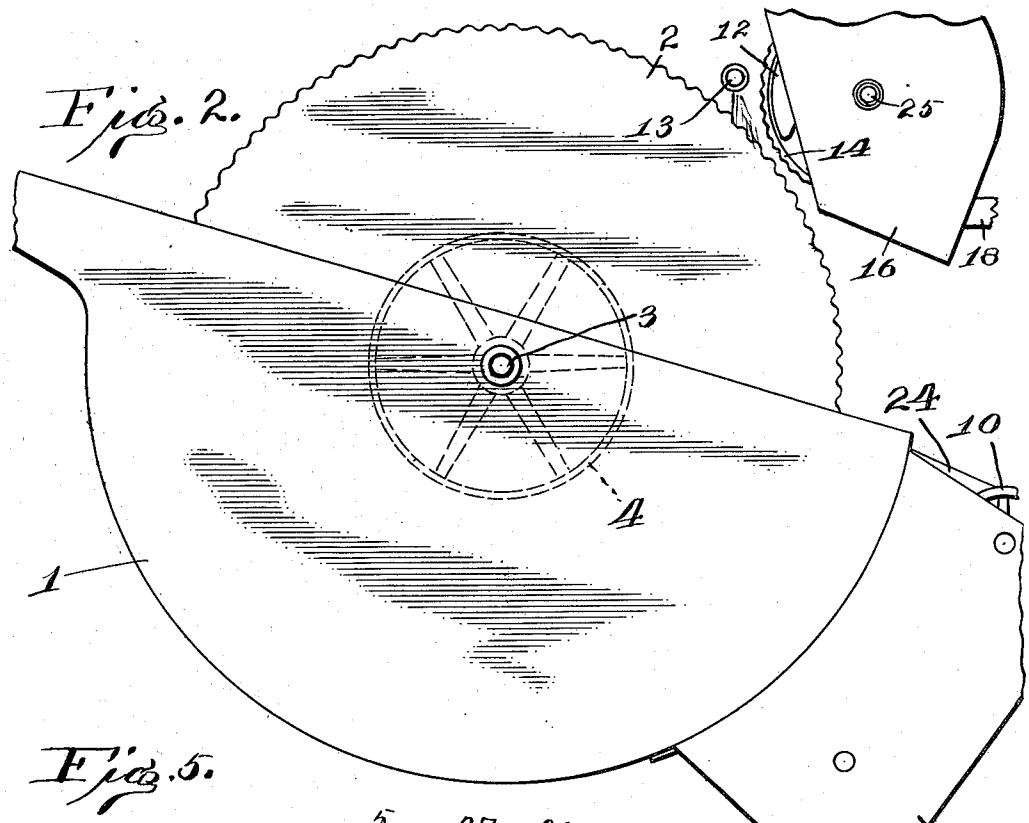
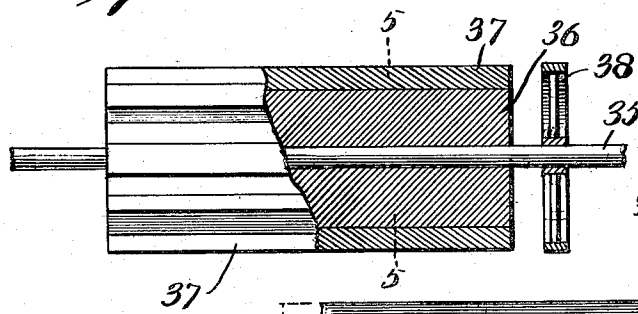


Fig. 5.



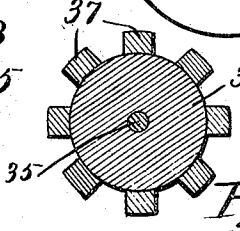
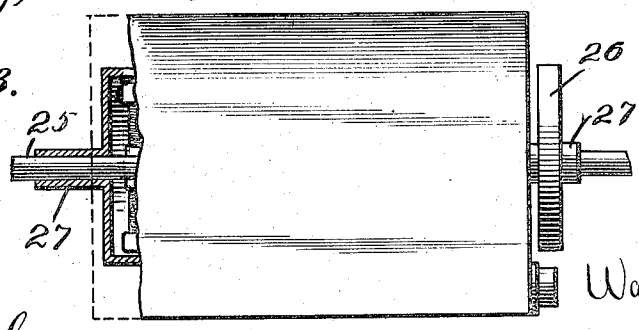


Fig. 6.

Fig. 3.



Witnesses

W. C. Isel.

A. L. Kitchin.

Inventor

Wayne D. Ludwick

By Mason, Fenwick & Lawrence

his Attorneys

W. D. LUDWICK.

MAGNETIC ORE SEPARATOR.

APPLICATION FILED SEPT. 22, 1906. RENEWED MAY 20, 1909.

939,523. **Patented Nov. 9, 1909.**

3 SHEETS—SHEET 3.

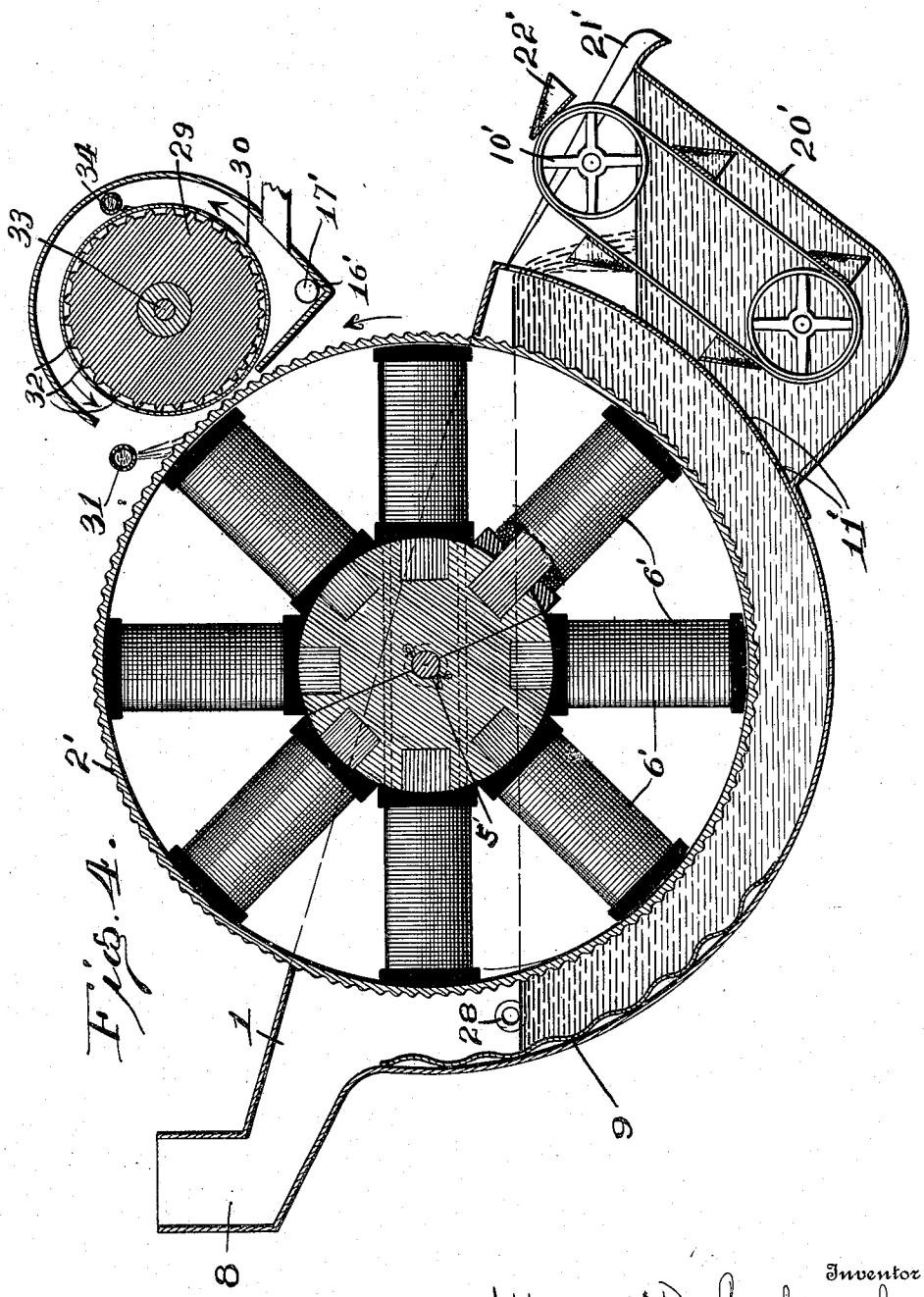


Fig. 4.

Witnesses

W. C. Isel.

A. L. Kitchin

Inventor

Wayne D. Ludwick

By Mason, Fenwick & Lawrence

his Attorneys.

UNITED STATES PATENT OFFICE.

WAYNE D. LUDWICK, OF SEATTLE, WASHINGTON, ASSIGNOR TO NORTHWEST METALLURGICAL COMPANY, OF SEATTLE, WASHINGTON, A CORPORATION.

MAGNETIC ORE-SEPARATOR.

939,523. Specification of Letters Patent. Patented Nov. 9, 1909.

Application filed September 22, 1906, Serial No. 335,724. Renewed May 20, 1909. Serial No. 497,328.

To all whom it may concern:

Be it known that I, WAYNE D. LUDWICK, a citizen of the United States, residing at Seattle, in the county of King and State of Washington, have invented certain new and useful Improvements in Magnetic Ore-Separators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in ore separators, and particularly to magnetic separators.

The invention comprises the production of a suitable pan or receptacle, a rotating drum positioned so as to have part of the periphery thereof inclosed by said pan, electromagnets positioned in said drum, and means for supplying and removing ore from said receptacle.

The invention further comprises the production of a receptacle, means for supplying ore thereto, and means for removing iron ore therefrom.

The object in view is the production of an ore separator in which electromagnets are used for removing iron ore from precious metal bearing ores.

With this and other objects in view the invention comprises certain other novel constructions, combinations and arrangements of parts as will be hereinafter more fully described and claimed.

In the accompanying drawings:—Figure 1 is a section through an ore separator embodying the features of the present invention. Fig. 2 is an end elevation of Fig. 1, certain parts being broken away. Fig. 3 is a side elevation of an auxiliary magnet and surrounding parts, forming part of my invention. Fig. 4 is a section through an ore separator embodying the features of the present invention in a slightly modified form. Fig. 5 is a view partially in longitudinal elevation and partially in section of a modified form of an auxiliary magnet forming part of my invention. Fig. 6 is a section through Fig. 5 on line 5—5.

In many instances in separating or refining gold bearing ores it has been found that the gold bearing ore has a large percentage of copper and iron mixed therewith, and when the gold is not of a considerable amount, it cannot be extracted to advantage because of the expensive processes which are required to remove the iron therefrom. If the ores were simply smelted, the gold or other valuable metals would be vaporized or burned before the iron in the ore could be melted. By being "burned" or vaporized, I wish it to be understood to mean that the gold or other valuable metal is vaporized or finely divided by the heat and is driven off with the smoke and consequently lost. For this reason many valuable gold deposits cannot be successfully worked because of the iron mixed with the gold bearing ore, or sand, as the case may be.

The present invention relates to improvements for overcoming the above difficulties suggested, through the use of magnets.

Referring more particularly to the drawings, 1 indicates a suitable pan or receptacle for containing water through which gold bearing ore or sand is adapted to be passed. As will be evident the gold bearing ore or sand must be pulverized by any means now in ordinary use before the same is passed through the pan 1. Mounted in the pan 1 is a drum 2 of non-magnetic material. The drum 2 is positioned so as to rotate partly in the pan 1 as will be clearly seen from Fig. 1 of the drawings. As will be seen from Fig. 2 of the drawings, the cylinder 2 is closed at each end for preventing the liquid from entering the interior thereof. It is also formed on each end with sleeves, as 3. As will be clearly seen from Fig. 2 of the drawings, a suitable driving means is secured to the sleeve 3, as pulley 4. The drum 2 is mounted upon a stationary shaft 5, and is adapted to rotate thereon.

Mounted within the cylinder 2 are a plurality of magnets 6, which are also mounted upon the stationary shaft 5, but are loosely mounted thereon so as to permit the same to swing slightly back and forth as may be desired. The magnets are preferably made up of laminations so as to more readily respond to the action of alternating currents when the same are used. The magnets 6 are preferably mounted in a soft iron hub 7 for providing a path for the magnetic flux passing between said magnet.

The drum 2 is preferably corrugated on its periphery, and is so positioned in the pan 1 as to leave only a comparatively small space between the bottom of the pan 1 and the lower edge of the drum. The drum is

arranged in this manner so as to be in close proximity to the ore as the same is fed into the chute 8 of the pan 1.

Secured in the pan 1 just below the chute 8 is a corrugated strip 9 against which the ore falls as the same is fed into the pan. As the ore passes over the corrugated strip 9 it is continually stirred and thus exposes any iron particles that the same may contain to the action of the magnetism that is projected from the magnets 6—6. The drum 2, which is revolving, also assists in keeping the ore moving as the same disturbs the water which partially fills the pan 1, and consequently keeps the ore moving as the same passes from the pan 1 to a conveyer 10. As the ore is fed into the pan through the chute 8 and the water in the pan is given a slight motion toward the conveyer 10, the ore gradually passes across the bottom of the pan 1 and through the perforations 11 formed in one side of the pan. In the passage of the ore from the chute 8 through the pan 1 to the conveyer 10, only the gold or copper bearing ore or other non-magnetic ore is permitted to pass through the apertures 11 in the bottom of the pan as shown to the conveyer 10 as the magnet 6 will attract all magnetic material and causes the same to adhere to the drum 2. After the material has been brought into contact with the drum 2, it will be carried with the drum 2 in its movement until it has passed the last of the magnets 6, and by the time it passes this point it will be brought under the influence of a secondary magnet 12, which will attract the same, and consequently remove all of the magnetic particles from the drum 2. In case the auxiliary magnet 12 fails to remove some of the magnetic material, a spray, as 13, may be provided which will effectually wash off any matter not picked off by the magnet 12. As the magnetic material is loosened by the spray 13 the magnet 12 will attract the same. As the magnet 12 attracts the magnetic particles from the drum 2, they are deposited upon a drum 14 of non-magnetic material which surrounds the magnet 12 and is adapted to rotate around the same. As will be observed from Fig. 1 of the drawings, the drum 2 rotates in one direction and the drum 14 in the opposite. The drum 2 rotates so as to bring the magnetic particles opposite the auxiliary magnet 12, and the drum 14 rotates in an opposite direction for removing such magnetic material out of the influence of the magnet 12 so that the same may be removed by the centrifugal action of the rotating drum 14, and also by the washing action of one or more sprays 15. After the magnetic material has been removed from the drum 14 it drops to the bottom of the pan or chute 16 and is washed or conveyed through an opening 17 to any suitable place, as may be desired. In case the water from the sprays 15 is not sufficient to remove the material from the pan 16, a pipe 18 may be provided through which water is forced into the pan 16 for assisting in removing the magnetic ore therefrom. The pan 16 is preferably provided with a shield 19 which almost entirely encircles the drum 14, so as to catch any magnetic material that may be thrown outward by the centrifugal action of the rotating drum 14.

Secured to the pan 1 below the openings 11 is a second or auxiliary pan 20 in which the conveyer 10 is mounted. As the magnetic ore is removed by the rotation of the drum 2 the non-magnetic ore will be permitted to pass through the apertures 11 into the auxiliary pan 20, and from said pan be conveyed to a chute 21 for dumping into any desired receptacle. As will be observed from Fig. 1 of the drawings, the conveyer 10 is provided with a number of buckets 22, which are perforated at 23, and are preferably provided with a wire netting or screen 24. The buckets are made in this manner so that as the same pass through the water in the auxiliary pan 20 they will take up the ore therein and permit the water to pass out the bottom thereof, and thus permit a minimum amount of water to be used in the separation of the various metals. This is of advantage as in many places where gold bearing ore or sand is found, the water is rather scarce, and the provision of a machine for using small amounts of water is absolutely necessary.

In the practical operation of my separator, I may use either direct or alternating currents as may be most convenient, but ordinarily prefer the use of alternating currents. In using alternating currents the magnetism in the magnets 6 is reversed in each alternation in the usual manner, and consequently the magnetic particles that have been attracted through the drum 2 are more strongly attracted at certain times than at other times, and consequently give a certain form of agitation to various matters adhering to the drum 2. As the drum 2 passes through the liquid contained in the pan 1, this slight agitation of the particles by the variation of the magnetic flux will permit all the non-magnetic material that may have been caught in with the magnetic material to escape, and consequently nothing but the magnetic material will be removed from the pan 1. This is the preferred way of operating my invention, but it will be evident that direct current can be used with excellent results, as the corrugations on the drum 2 will sufficiently agitate the water in the pan for keeping the ore therein constantly moving, and as a result particles of magnetic material will be attracted to the drum 2.

In regard to the use of direct and alternating currents, the auxiliary magnet 12 is adapted to use either as may be desired. The

magnet 12 is mounted upon a stationary shaft 25, and is rigidly secured thereto so as to always hold the poles of the magnet in proximity to the cylinder 2. This will keep the magnetic flux from said magnet close enough to the drum 2 to always attract substantially all of the magnetic particles that the drum 2 removes from the pan 1. As will be clearly seen from Fig. 3 of the drawings, the drum 14 is rotated by any suitable driving means, as the pulley 26, which is rigidly secured to one of the sleeves 27.

Referring more particularly to Fig. 4 of the drawings, it is seen that I have provided a device similar in general principle to the device shown in Fig. 1 of the drawings, but have modified the practical arrangement thereof. In the modification, I have provided a plurality of magnets 6′, which are equally spaced entirely around the shaft 5′. Surrounding the magnets 6′ is a drum 2′ which is similar in all respects to drum 2, but is rigidly secured to the shaft 5′ as well as the magnets 6′, and rotates therewith. The shaft 5′ is rotated by any suitable means. In the practical operation of the modification, as shown in Fig. 4 of the drawings, the pan 1 is partially filled with water and maintained at a predetermined level by water entering through pipe 28. As the ore is fed into the chute 8 and passes downward through the pan 1, cylinder 2′ and magnets 6′ rotate and keep agitated the ore as the same passes through the liquid in the same manner as described, and shown in Fig. 1. As the drum 2′ passes through the liquid the magnetic materials will be attracted and held in contact with the drum until they come opposite an auxiliary magnet 29. As they come opposite the auxiliary magnet 29, they are attracted from their position on the drum 2′ over to the drum 30 that surrounds the magnet 29. A spray, as 31, is provided for assisting the magnet 29 in loosening and removing magnetic ore from the drum 2′. The magnet 29 is preferably made from a solid piece of soft iron throughout, and has formed on the periphery thereof a number of projections 32. The magnet 29 is mounted upon a rotating shaft 33, and is rigidly secured thereto, and is consequently adapted to rotate therewith. The magnet 29 is not supplied with electrical current of any kind, but is magnetized from magnetism passing from the magnets 6′ as the same pass in revolving. As the magnets 6′ pass the magnet 29 in revolving, the major portion of the magnetism is concentrated at the points 32 and consequently afford a strong attraction for the magnetic particles that have been loosened by spray 31. As the magnetic material is loosened by the spray 31 it passes over and engages the drum 30, which is preferably smooth on its periphery so as to have the magnetic material easily washed therefrom by a suitable spray 34. A tray 16′ and a suitable discharge opening 17′ is provided for collecting and removing the magnetic material that is washed from the drum 30. The auxiliary magnet 29 is not supplied with electrical current, as I have just described, but the magnets 6′ are supplied with either direct or alternating currents as in the preferred construction disclosed in Fig. 1 of the drawings. As the magnetic material is removed by the drum 2′ the other ore passes through the openings 11′ into a receptacle 20′, and is conveyed therefrom by a suitable conveyer 10′ in the same manner as in the preferred construction.

In Figs. 5 and 6 of the drawings, I have shown another modification of an auxiliary magnet, which may be used as a substitute for magnet 29 or 12, as may be desired. In the structure disclosed in Figs. 5 and 6, I provide a rotating shaft 35 upon which I mount a cylinder or core 36, preferably made from wood. Upon the periphery of the cylinder or core 36, I secure any suitable number of soft iron bars or rods 37. In practical operation the cylinder or core 36, together with the bar 37 is revolved by means of any suitable mechanism as pulley 38. No current is supplied to this form of auxiliary magnet, and the same is particularly adapted for use in the modified form shown in Fig. 4 of the drawings, in order that the bars 37 may be magnetized by the magnets in the drum 2′. As the bars 37 are thus magnetized, they will attract the magnetic material from the drum 2′ as the same is loosened by the spray 31.

By constructing a device according to the present invention, iron ores may be easily and readily removed from ores bearing valuable metals without in the least injuring the same. A device is also produced in which a comparatively small amount of water is used in the operation of removing the iron ore from the sand or pulverized ore, and consequently permits the device to be used in many places where there are more or less valuable gold deposits and but very little water.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. An ore separator comprising a receptacle, a drum mounted to rotate within the receptacle, a plurality of magnets spaced about the lower interior portion of the drum, means to pass ore through the receptacle, magnetic means to remove magnetic material from the exterior of the drum and means for simultaneously loosening the said magnetic material from the separating drum by spraying within the field of the magnetic removing means.

2. An ore separator comprising a recep-

tacle, a drum mounted to rotate in the receptacle, a plurality of magnets spaced about the lower interior portion of the drum, a chute adapted to introduce material into the receptacle, means to discharge waste material from the receptacle, magnetic means to remove magnetic material from the exterior of the drum, and means for simultaneously loosening the said magnetic material from the separating drum by spraying within the field of the magnetic removing means.

3. An ore separator comprising a receptacle, a drum mounted to rotate within the receptacle, magnets spaced about the lower interior portion of the drum, means to introduce material into the receptacle, a pan secured to and adapted to receive refuse from the receptacle, means to discharge material from the pan, magnetic means to remove magnetic material from the drum, and means for simultaneously loosening the said magnetic material from the separating drum by spraying within the field of the magnetic removing means.

4. An ore separator comprising a receptacle, a drum mounted to rotate within the receptacle, a plurality of magnets spaced about the lower interior portion of the drum, means to pass ore through the receptacle, a pan in communication with the receptacle and adapted to receive refuse material therefrom, a conveyer mounted in the pan, magnetic means to remove magnetic material from the exterior of the drum, and means for simultaneously loosening the said magnetic material from the separating drum by spraying within the field of the magnetic removing means.

5. An ore separator comprising a receptacle, a drum mounted to rotate in the receptacle, a plurality of magnets spaced about the lower interior portion of the drum, means to pass ore through the receptacle, magnetic means disposed adjacent the drum and above the inclosed magnets and adapted to remove magnetic material from the exterior of the drum, and means for simultaneously loosening the said magnetic material from the separating drum by spraying within the field of the magnetic removing means.

6. An ore separator comprising a receptacle, a drum mounted to rotate within the receptacle, a plurality of magnets positioned about the lower interior portion of the drum, means to pass ore through the receptacle, a magnet adjacent the periphery of the drum and above the magnets first mentioned and adapted to remove magnetic material from the exterior of the drum, and means for simultaneously loosening the said magnetic material from the separating drum by spraying within the field of the magnetic removing means.

7. An ore separator embodying a casing segmental in form, a corrugated strip secured to the inner wall of the casing, a drum mounted to rotate within and spaced from the segmental wall of the casing, an auxiliary pan secured at one side of and positioned to receive discharge from the casing, means to introduce material into the casing, a conveyer mounted and adapted to be actuated within the auxiliary pan, a chute arranged to receive discharge from the conveyer, magnets located within the drum, magnetic means for removing magnetic material from the exterior of the drum, and means for simultaneously loosening the said magnetic material from the drum by spraying within the field of the magnetic removing means.

8. In a device of the class described, a magnetic ore separating device, a spraying means for loosening the magnetic particles attracted thereto, and magnetic means for simultaneously removing said particles from the separating means.

In testimony whereof I affix my signature in presence of two witnesses.

WAYNE D. LUDWICK.

Witnesses:
G. WARD KEMP,
A. C. JOHNSON.