

April 26, 1949.

C. P. TOWNSEND
PROCESS AND APPARATUS FOR SEPARATION OF
ELECTRICALLY CONDUCTING MATERIAL FROM
NONCONDUCTING MATERIAL
Filed April 1, 1946

2,468,472

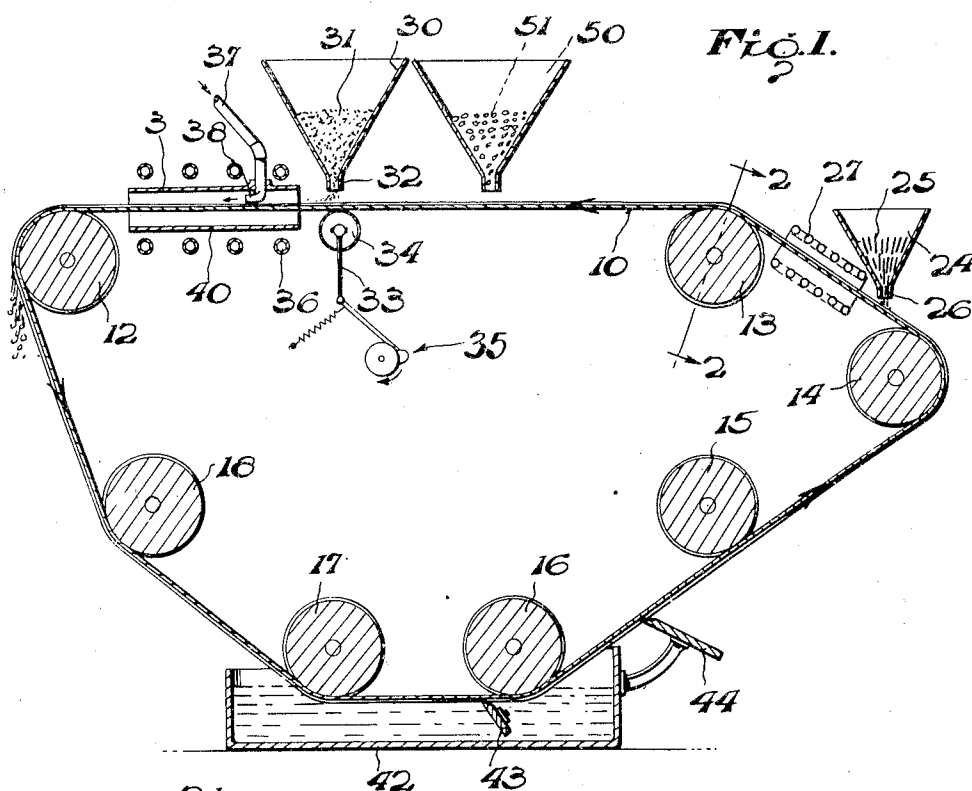
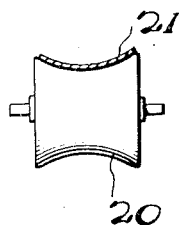
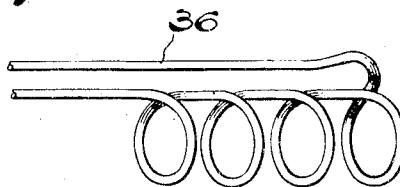


Fig. 2.

Fig. 3.



INVENTOR.

Charles P. Townsend

BY

Herbert M. Birch
Attorney

UNITED STATES PATENT OFFICE

2,468,472

PROCESS AND APPARATUS FOR SEPARATION OF ELECTRICALLY CONDUCTING MATERIAL FROM NONCONDUCTING MATERIAL

Charles P. Townsend, Abbeville, S. C.

Application April 1, 1946, Serial No. 658,622

20 Claims. (Cl. 209—49)

1

My invention relates generally to a novel process and apparatus for the separation of electrically conducting material from non-conducting material, and more particularly to a novel process for the separation of metals, conducting metallic compounds, or alloys, from non-conducting materials with which they might be mixed.

My process is particularly useful in connection with mining operations where metal bearing ores are taken from the mine in large blocks or lumps containing relatively large quantities of non-metallic materials, which must be thoroughly and quickly separated from the precious metal or the like in the blocks.

Heretofore, such ore lumps after they are crushed into fine or coarse particles preparatory to separating the metallic particles from the non-metallic have been separated by some mechanical or electrical means. Usually such prior separating processes and apparatus are slow and inefficient, and accordingly one object of my invention is to provide a novel improved process for rapidly and efficiently separating metal particles from non-metallic particles in crushed ore lumps.

Another object is to provide a novel process adapted for separating two or more conducting materials, wherein the conducting materials have a considerable relative difference to each other in conductivity.

A further object is to provide novel apparatus with which to efficiently practice my novel process.

The above and further objects and advantages of my novel process will more fully appear from the following detailed description thereof, in which one form of apparatus for practicing the novel process is described and illustrated in connection with the accompanying drawing.

It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not intended as a definition of the limits of the invention; for this latter purpose reference should be had to the appended claims.

In the drawing:

Figure 1 is a semi-diagrammatic illustration of one form of apparatus such as may be used to practice the novel process.

Figure 2 is a front view of one of the top rollers with the endless conveyor belt held in transverse section to show the concave surface thereof for providing a material receiving trough in the belt's surface.

Figure 3 is a semi-diagrammatic view of the hollow high frequency heating coil showing its

2

connections to a suitable source of current supply.

Broadly, the present process comprises the steps of selectively heating only the conducting particles contained in a mixture, applying said mixture to a normally cold non-conducting non-adhesive surface adapted to develop adhesive qualities when heated, either prior or subsequent to the selective heating of the conducting particles, so that the heated conducting particles will adhere or imbed themselves in the surface and the cold non-conducting particles do not adhere to the surface.

The method by means of which the selective heating of the conducting, or metallic, particles of a mixture including conducting, or metallic, particles and non-conductive particles, is accomplished is by bringing this mixture within the immediate-magnetic field of a high frequency induction heating coil, as shown for example in Figure 1.

This high frequency induction heating causes the transfer of electrical energy from a high frequency current carrying conductor, called the heating coil, to the conducting material, such as metals, in its immediate vicinity. This heating coil when energized by the high frequency current sets up a field of magnetic flux that energizes this conducting material, or metals, in such a way that current is induced, or caused to flow, within this material, particularly around its surface, and the electrical resistance of this material causes an immediate heating action from the induced current.

This high frequency current, which energizes the heating coil, may be of various frequencies from 60 cycles per second to 1,000,000 cycles per second, or even higher. In the present process frequencies of from 10,000 cycles per second to 500,000 cycles per second are most generally used. This high frequency current is generated by rotary generators within the approximate limits of from 60 cycles per second to 10,000 cycles per second, and by vacuum tube generators or spark-gap converters at from 10,000 cycles per second to 500,000 cycles per second, and by vacuum tube oscillators at from 500,000 cycles per second to 1,000,000 cycles per second, and by electron tube oscillators above 1,000,000 cycles per second.

There are numerous agents which could be used for this selective heat responsive adhesive surface, such as asphalt, tar, paraffine, paints, etc., too numerous to mention, about the only requirement being that the consistency must be such that a non-heated particle of material in

contact with it will not have a tendency to stick, while a heated particle will make the surface adhesive at its particular point of contact and stick by melting or softening the normally cold non-adhesive surface where it makes contact. For instance, ordinary caramel candy, purchased in any candy store, would have most of the qualities required to make a good adhesive agent.

The cold non-conducting, or non-adhering, material can easily be separated from the adhesive agent with the conducting or metallic material attached, as herein explained. This adhesive agent with the conducting or metallic material attached can then be processed by some of the usual methods, such as the application of heat to melt the agent and straining, settling or centrifuging the conducting or metallic particles out of the mixture; or by dissolving the adhesive agent in a solution and separating as above. This latter would probably be the process used if caramel candy was used as the adhesive agent. In some instances the adhering particles could be brushed or scraped from the adhesive surface.

Referring to the drawing in detail, which illustrates one arrangement for practicing the present invention, the embodiment comprises an endless conveyor belt 10 driven by any suitable power mechanism, not shown. This belt 10 rotates over a plurality of pulleys 12, 13, 14, 15, 16, 17, and 18.

The top pulleys 12 and 13 are formed with a concave exterior or face 20 as shown in Fig. 2, so that the upper surface of the belt 10 will assume a concave form or trough 21 to better hold the mixtures to be separated.

The pulley or drum 14 over which the belt feeds has a level cylindrical surface, and mounted over and near the pulley 14 is a hopper 24. The hopper 24 contains a substance 25 which is adhesive when heated or melted. This substance 25, which may be any of a number of substances previously mentioned, is made fluent by heat so that it flows out through an elongated opening 26 extending across the belt 10 to thereby spread a coating of this substance on the conveyor belt. From this point the belt feeds through a cooling station 27, if desired, to cool the substance into a cold non-adhesive state. Such cooling, if needed, may comprise a housing with cooling coils or merely cooling fans, not shown.

After the belt is coated with the substance 25 it feeds forward around roller 13 with the concave surface and under a hopper 30. The hopper 30 contains a mixture of conducting and non-conducting materials 31 to be separated, which material is allowed to feed onto the coated conveyor belt 10 through an opening 32 at the bottom.

Mounted on a rocker arm 33 directly under the belt 10 below the discharge outlet 32 of hopper 30 is an idler pulley 34.

The idler pulley 34, through the spring loaded rocker arm 33, is given a shaking or vibratory movement which is transmitted to the belt 10 by suitable means, such as by cam 35, with which it is in contact and which in turn keeps the mixture of conducting and non-conducting materials 31 agitated or vibrated on the belt 10 as they pass through the confines of a heating coil 36.

As a further means of agitating these materials compressed air, or some other gas or mixture of gases, from a source not shown, is introduced through the tube 37 of some non-conducting substance, such as glass, and out through the nozzle 38, as the material passes through the heating coil 36. The heating coil 36 is formed

or wound on a cylinder 40, of some non-conducting substance such as glass, which prevents the mixture from being blown away and guides it in its passage through the heating coil.

A high frequency current energizes the coil 36 as previously explained and the conducting particles of the mixtures are heated and stick to the adhesive substance 25 on the belt 10 in their passage through the heating coil 36. The agitation or vibration from pulley 34 and nozzle 38 allows a greater number of these particles to contact the adhesive substance and so increases the efficiency of the separation.

As the conveyor belt 10 moves the particles from the heating coil 36, it passes over the pulley 12, and the cold particles not adhering to the substance 25 on the belt, and which are composed almost entirely of the non-conducting particles, are dumped off by gravity or blown off by means of a blast of air conveyed to this area from the nozzle 38 or any other convenient source, and segregated in any convenient way.

The conducting particles sticking to the adhesive coating of the belt 10 cool and continue to stick until they are carried through the tank 42 which contains some suitable solvent for the coating on the belt 10 or some heated liquid, which loosens or dissolves this coating, with scrapers 43 and 44 for removing the balance of this adhesive coating.

The conducting particles are then processed, or removed from this adhesive substance, or the solution in some convenient manner.

If desired, an alternate form of separating substance 25 may be utilized. This substance is shown housed in the hopper 50. The hopper 50 contains pellets 51, or particles of the adhesive substance 25, larger than the particles of the material to be separated, which feed onto the belt 10, from an opening in the lower part of this hopper 50, and so pass through the heating coil 36, with the material to be separated. The conducting particles being heated adhere to these adhesive pellets 51 and are dumped by gravity along with the non-conducting particles when the belt 10 passes over the pulley 12.

These adhesive pellets, with their attached conducting particles, may then be separated by screening, or some other method, from the non-conducting particles.

These adhesive pellets 51 may be used alone or in connection with an adhesive coating on the belt 10.

The shape of the heating coil 36 may vary over a wide range of different shapes; it may be flat, square, ellipsoidal, rectangular, conical, pyramidal or other shapes too numerous to list.

This heating coil 36 itself must, in some instances, be cooled, and this may be done by making it from tubing and circulating water through this tube, as indicated by the arrows in Figure 3.

Where hoppers are shown as containers for materials, other types of storage bins, boxes or containers may be used. Also where materials are shown as being fed or sifted from the bottom of these hoppers, other methods may be used for dropping, blowing, or feeding varying quantities of such materials from containers.

Where the adhesive material is shown as flowing from the hopper 24 onto the surface of the belt 10, other methods of applying may be used, such as brushing or spraying.

While my process has been described in considerable detail and the one embodiment of an

5

apparatus for practicing the same has been specifically described and illustrated, various changes and modifications, which now appear to those skilled in the art, may be made without departing from the scope of the invention.

Reference should be had to the appended claims for a definition of the limits of the invention.

I claim:

1. The process of separating electrically conductive bodies from mixtures including non-conductive bodies, comprising the following steps: feeding a mixture to be separated onto a heat responsive selective adhesive surface, conveying said surface with the mixture into the vicinity of a coil charged with high frequency current and through the magnetic field produced from the coil to heat the conductive bodies in the mixture and thereby cause the said heated bodies to adhere to the coated surface, then conveying said coated surface with the mixture from the heating field in the vicinity of the coil, removing the loose non-conducting bodies from the coated surface, and then chemically treating the coated surface to remove the adhering conducting particles.

2. The process of separating electrically conductive bodies from mixtures including non-conductive bodies, comprising the following steps: feeding a mixture to be separated onto a coated heat responsive selective adhesive surface, conveying said surface with the mixture into the vicinity of a coil charged with high frequency current and through the magnetic field produced from the coil to heat the conductive bodies in the mixture, vibrating the coated surface to settle the heated bodies onto the coated surface to make said surface adhesive where it contacts said heated bodies, conveying the surface from the heating field, removing the non-conductive bodies from the coated surface by gravity, and then dissolving the coated surface in a solvent to separate the electrically conductive bodies therefrom.

3. Apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, comprising an endless belt adapted to travel through coating, loading, heating and separating zones, means mounted over said belt adapted to spread a coating thereon at said coating zone, said coating being of a type adapted to become adhesive only when heated, a second means mounted over said belt beyond the coating zone adapted to load said belt with a mixture including electrically conducting and non-conducting bodies, a hollow tube of insulation around such belt beyond the said loading zone, means for agitating said mixture in the tube, a coil wound on the outside of said tube connected to a high frequency a. c. current generator adapted to induce current in said conductive bodies in the said mixture on the belt, to thereby inductively heat the said bodies, said bodies in their heated state settling into contact with the coated surface on said belt, to thereby adhere and embed into the coating on the belt, said belt turning abruptly down from the said heating zone, so as to drop off by gravity all non-adhering bodies from the coated surface, a tank containing a solvent for said coating for immersing the belt with the adhering conducting bodies thereon, and scrapers for removing the conducting bodies and the coating from the belt.

4. Apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, comprising an endless belt

6

adapted to travel through coating, loading, heating and separating zones, a plurality of belt driving pulleys, said pulleys being arranged to provide a sloping plane at said coating station and a horizontal plane of the belt at said loading station for receiving the mixture to be separated, said pulleys at each end of said horizontal plane having concave surfaces over which the belt travels, to thereby provide a trough in the belt, a mixture discharge hopper mounted over part of said horizontal plane of the belt, a vibrator pulley below the surface of the belt adapted to vibrate the same below the hopper outlet, a hollow tube of insulation around said belt beyond the said loading zone, means for agitating said mixture in the tube, a coil wound on the outside of said tube connected to a high frequency a.c. current generator adapted to induce current in said conductive bodies in the said mixture on the belt, to thereby inductively heat the said bodies, said bodies in their heated state settling into contact with the coated surface on said belt, to thereby adhere and embed into the coating on the belt, said belt turning abruptly down from the said heating zone, so as to drop off by gravity all non-adhering bodies from the coated surface, a tank containing a solvent for said coating for immersing the belt with the adhering conducting bodies thereon, and scrapers for removing the conducting bodies and the coating from the belt.

5. Apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, comprising conveyor means, a selective adhesive material responsive to heat only on said means, a feed hopper over said conveyor means for supplying a mixture thereon to be separated, means for agitating said mixture to thereby facilitate contact with said adhesive material, a coil mounted around said conveyor means connected to a source of high frequency current, said conducting bodies in said mixture serving as a secondary circuit for the current and having the properties of resistance such as to cause them to be heated by the current induced therein from said coil, whereby the heated conductive bodies contact and stick to the said selective adhesive material, said conveyor being arranged to discharge the unheated non-conductive bodies separately from the discharge of the adhesive material with the conducting bodies adhering thereto.

6. The apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, as described in claim 5, wherein the said coil is hollow to provide for the circulation of cooling fluid while it is energized.

7. The apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, as described in claim 5, wherein the said adhesive material is a caramel candy mixture or the like.

8. The apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, as described in claim 4, wherein said adhesive material is a caramel candy mixture and said solvent is hot water.

9. The apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, as described in claim 5, wherein said adhesive is in pellet form.

10. The apparatus for separating electrically conductive bodies from mixtures including non-conductive bodies, as described in claim 4, wherein said adhesive includes a separate supply

of pellets in combination with said coating on the belt.

11. The process of separating electrically conductive bodies from dry mixtures including electrically non-conductive bodies, comprising the steps of feeding the dry mixture through a high frequency magnetic field to thereby heat the electrically conductive bodies, maintaining the mixture in contact with a material having heat responsive selective adhesive properties for heated bodies and thereby cause the said heated bodies to adhere to the surface of the heat responsive selective adhesive material; removing the selective adhesive material from within the high frequency magnetic field with the dry mixture, then separating the electrically conductive bodies from the said adhesive material by first removing the non-conducting bodies and then treating the adhesive material to remove the conducting particles adhering thereto.

12. The process of separating electrically conductive bodies from mixtures including electrically non-conductive bodies, comprising the following steps: Feeding a mixture to be separated onto a surface made adhesive when contacted by heated bodies, conveying said surface with the mixture to be separated into the vicinity of the field of a coil charged with high frequency electric current and thus inducing current within said electrically conducting bodies in the mixture to heat them and thereby cause them to adhere to the heat responsive adhesive surface, passing the mixture coated surface from the field of the coil, removing the electrically non-conductive bodies from this surface, then chemically treating said surface, and then mechanically removing the electrically conductive bodies from this surface.

13. The process as described in claim 12, wherein the frequency of said current for inductively heating the said conductive bodies in the mixture is from 60 cycles per second to 1,000,000 cycles per second.

14. The process of separating electrically conductive bodies from mixture including non-conductive bodies, comprising the following steps: Feeding a mixture to be separated onto a heat responsive selective adhesive surface, conveying said surface with the mixture into the vicinity of a coil charged with high frequency current and through the magnetic field produced from the coil to heat the conductive bodies in the mixture and thereby cause the said heated bodies to adhere to the said surface, then conveying said surface with the mixture from the heating field in the vicinity of the coil, removing the loose non-conductive bodies from the said surface, and then mechanically removing the adhering conductive bodies from the said surface.

15. The process of separating electrically conductive bodies from mixtures including electrically non-conductive bodies, comprising the following steps: feeding a mixture to be separated, together with pellets having a coated heat responsive selective adhesive surface, into the vicinity of a coil charged with high frequency electric current and through the magnetic field produced from the coil to heat the electrically conductive bodies in the mixture and thereby cause the said heated bodies to adhere to the coated surface of the pellets, then conveying said pellets with the mixture from the heating field in the vicinity of the coil, separating the loose non-conductive bodies from the pellets, and then chem-

ically treating the pellets to remove the adhering conductive bodies from the coated surface.

16. The process of separating electrically conductive bodies from mixtures including electrically non-conductive bodies, comprising the following steps; feeding a mixture to be separated, together with pellets having a coated heat responsive selective adhesive surface, into the vicinity of a coil charged with high frequency electric current and through the magnetic field produced from the coil to heat the electrically conductive bodies in the mixture and thereby cause the said heated bodies to adhere to the coated surface of the pellets, then conveying said pellets with the mixture from the heating field in the vicinity of the coil, separating the loose non-conductive bodies from the pellets, and then mechanically removing the adhering conductive bodies from the coated surface of the pellets.

17. The process of separating electrically conductive bodies from mixtures including non-conductive bodies, comprising the following steps: Feeding a mixture to be separated onto a coated heat responsive selective adhesive surface, conveying said surface with the mixture into the vicinity of a coil charged with high frequency current and through the magnetic field produced from the coil to heat the conductive bodies in the mixture, vibrating the coated surface to settle the heated bodies onto the coated surface to make said surface adhesive where it contacts said heated bodies, conveying the surface from the heating field, removing the non-conductive bodies from the coated surface by gravity, and then mechanically removing the adhering conductive bodies from the coated surface.

18. The process of separating electrically conductive bodies from mixtures including electrically non-conductive bodies, comprising the following steps: Feeding a mixture to be separated onto a surface made adhesive when contacted by heated bodies, conveying said surface with the mixture to be separated into the vicinity of the field of a coil charged with high frequency electric current and thus inducing current within said electrically conducting bodies in the mixture to heat them and thereby cause them to adhere to the coated heat responsive selective surface, passing the mixture coated surface from the field of the coil, removing the loose non-conductive bodies from the coated surface by means of a blast of air, then chemically treating said surface, and then mechanically removing the electrically conductive bodies from this surface.

19. The process of separating electrically conductive bodies from mixtures including electrically non-conductive bodies, comprising the following steps: Feeding a mixture to be separated onto a surface made adhesive when contacted by heated bodies, conveying said surface with the mixture to be separated into the vicinity of the field of a coil charged with high frequency electric current and thus inducing current within said electrically conducting bodies in the mixture to heat them and thereby cause them to adhere to the coated heat responsive selective surface, passing the mixture coated surface from the field of the coil, removing the loose non-conducting bodies from the mixture coated surface by gravity, then chemically treating said surface, and then mechanically removing the electrically conductive bodies from this surface.

20. The process of separating electrically conductive bodies of low resistance from mixtures including electrically conductive bodies of rela-

tively high resistance, comprising the following steps: Feeding a mixture to be separated onto a heat responsive selective adhesive surface, conveying said surface with the mixture into the vicinity of a coil charged with high frequency current and through the magnetic field produced from the coil to heat the electrically conductive bodies of low resistance in the mixture and thereby cause the said heated bodies to adhere to the said surface, then conveying said surface with the mixture from the heating field in the vicinity of the coil, removing the loose electrically conductive bodies of relatively high resistance from the said surface, and then chemically treating the

said surface to remove the adhering conducting particles.

CHARLES P. TOWNSEND.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,726,431	Fourment	Aug. 27, 1929
1,744,989	Sherer	Jan. 28, 1930
2,048,316	Beatty	July 21, 1936
2,189,698	Bierbrauer	Feb. 6, 1940