Feb. 18, 1936. E. GROSSENBACHER 2,030,982

TRAMP IRON COLLECTOR

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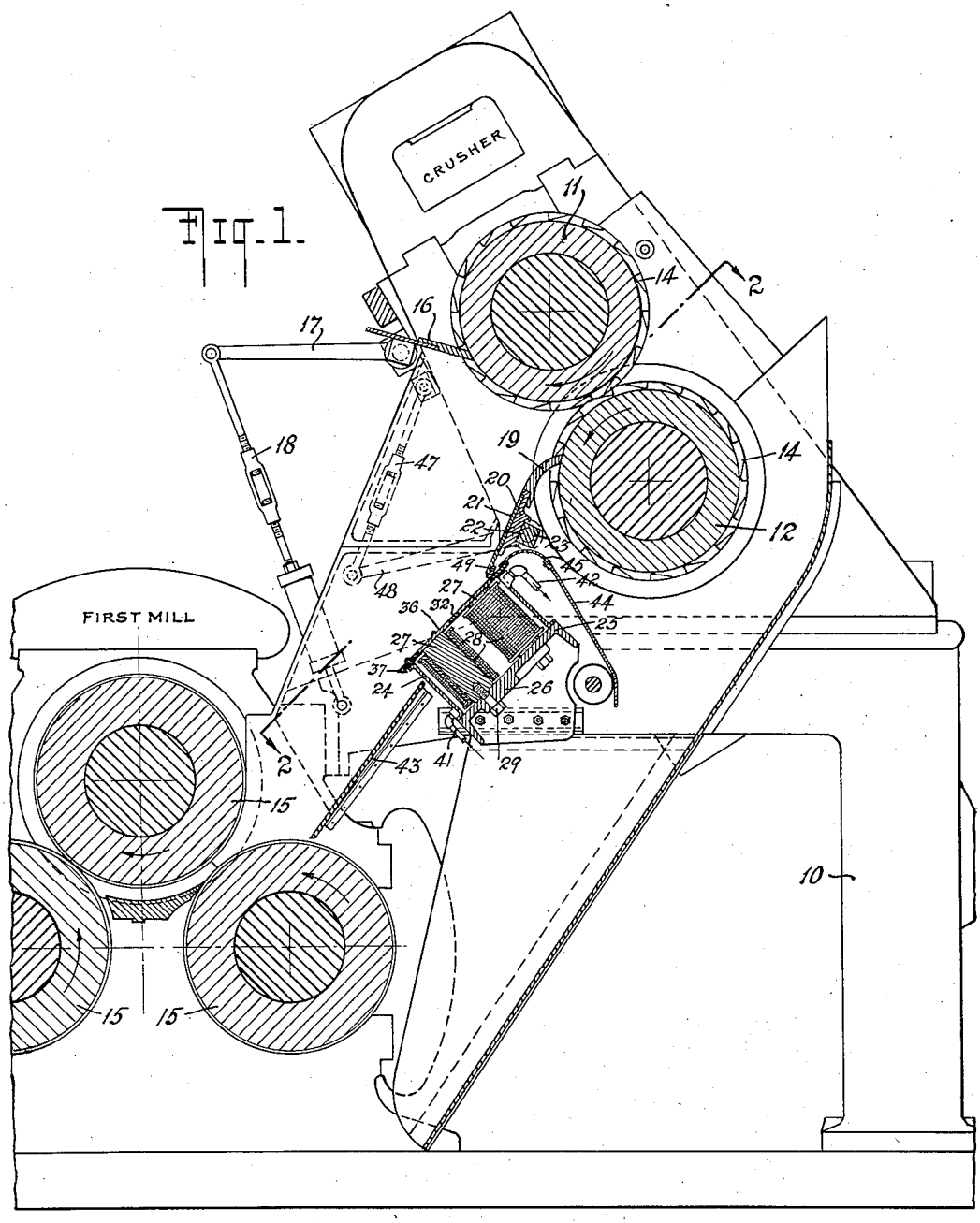
Fig. 1.



WITNESS

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Fig. 2.

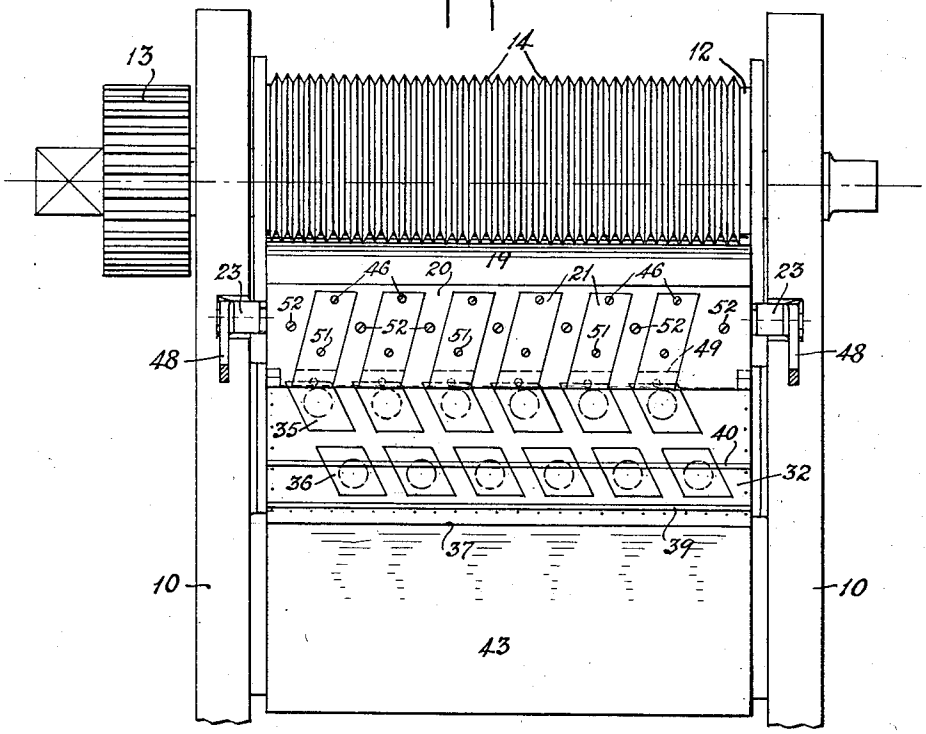
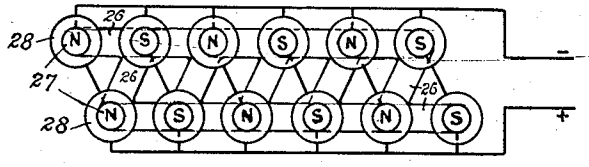


Fig. 7.



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TRAMP IRON COLLECTOR

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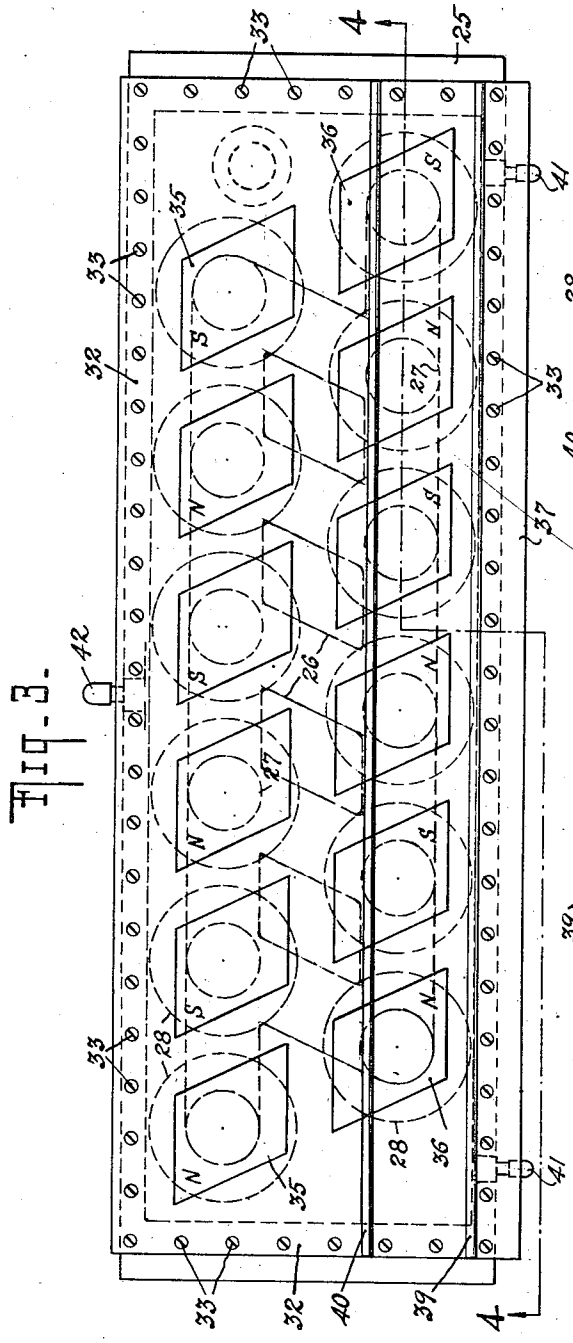

Fig. 3.

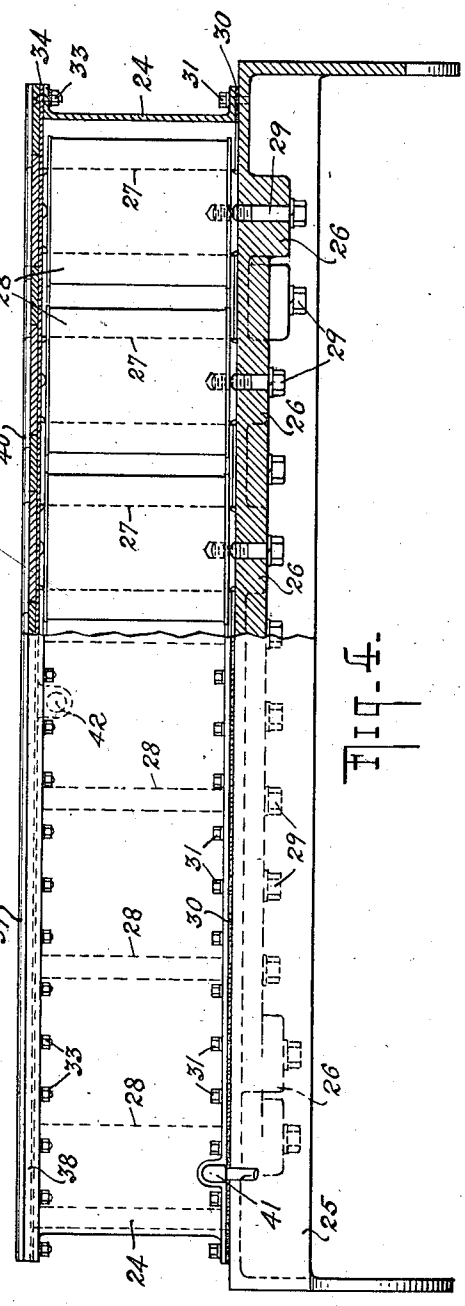

Fig. 4.

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TRAMP IRON COLLECTOR

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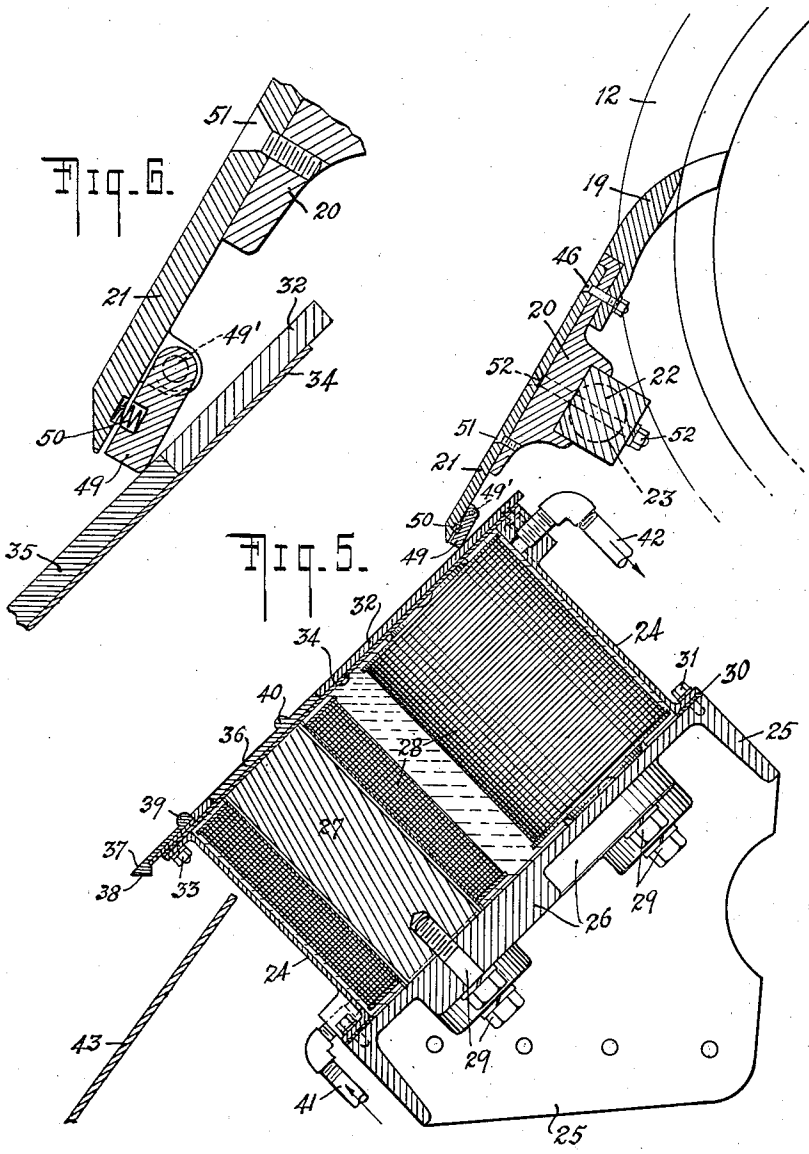
Fig. 6.

Fig. 5.



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UNITED STATES PATENT OFFICE

2,030,982

TRAMP IRON COLLECTOR

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Application August 15, 1934, Serial No. 740,025

9 Claims. (Cl. 209—215)

This invention relates generally to apparatus for crushing sugar cane or similar material, in which apparatus such material is crushed by suitable devices and the juice extracted therefrom.

More specifically the invention relates to mechanism of a magnetic type for separating and collecting so-called tramp iron from the material operated upon so as to prevent damage to the machinery by such tramp iron by having the same come into contact with the closely set mills forming a portion of the cane crushing and juice extracting apparatus.

The tramp iron which my novel apparatus is designed to extract from the sugar cane consists of nuts, bolts, chain pieces, rail spikes, etc., and similar iron or steel parts which may have become separated from machinery used in cultivating and harvesting the cane and are picked up with such cane. Magnetic separators have heretofore been installed at the bottom of or below the chute between the crusher rolls and the first of a series of mills in an attempt to prevent the passage of such tramp iron to the mills, thereby causing damage thereto. Such magnetic separators, however, have failed to extract all of the tramp iron, especially when thick mats of crushed cane pass from the crusher rolls to the first mill as in installations, including revolving knives, employed for the preparation of the cane prior to passage thereof through the crusher.

In accordance with the present invention, the extraction of the tramp iron from the cane, which has been previously subjected to the action of revolving cane knives placed ahead of the crusher rolls in order to increase the tonnage or capacity of the mills and in order better to prepare the sugar cane for crushing and to obtain a more perfect extraction of the sugar juice, is commenced at a point where the cane approaches the lower crushing roll prior to such cane actually passing between the crusher rolls. This is accomplished by imparting a strong magnetization to the lower crusher roll so that loose iron pieces traveling with the cane become attracted to such lower crusher roll and held thereon until loosened by a scraper operative upon such roll. In accordance with the invention, therefore, the lower crusher roll constitutes the first point at which the separation of the tramp iron from the crushed cane is accomplished. In order to effect this result, the scraper operative upon the lower crusher roll is magnetized so that it prevents tramp iron from reentering the mat of crushed cane as the latter is pushed from the lower crusher roll by the flow of crushed cane toward the first of the closely set mills of the sugar cane treating apparatus.

As the upper crusher roll is usually provided with a series of peripheral grooves, the magnetization of the lower crusher roll and the withdrawal of tramp iron from the sugar cane passing therefrom will prevent such tramp iron from becoming clogged in the grooves of the upper crusher roll and thereby rendering such upper roll inoperative to effect its intended function. If tramp iron were permitted to become clogged in the grooves of such upper crusher roll, it is possible that such iron would be dislodged from such grooves by the scraper and dropped therefrom onto the crushed cane below the roller and be carried upon the surface of the mat of crushed cane into the mill.

While it has been heretofore suggested, as pointed out hereinabove, to place a separator magnet between the crusher roll and the first mill, no practical installation of such a device is possible in the ordinary sugar cane mill as the blanket of crushed cane flowing from the crusher roll to the mill ranges in thickness from 6 to 24 inches so that it is virtually impossible to build a separator magnet of sufficient size to extract a piece of iron from the mat of cane by pulling the same through such a thickness of mat when the sugar cane mill is operated at anywhere near normal capacity, such, for instance, as at the rate of 100 to 130 tons per hour, with a mill width of 78 inches. In accordance with the present invention, the tramp iron is kept in contact with the magnetized lower crusher roll and is thus prevented from being lifted above the blanket of crushed cane adhering to the upper crusher roll and such tramp iron is prevented from leaving the scraper by which it is removed from the crusher and re-entering the crushed cane mat from above.

In accordance with the invention, therefore, a magnetic element is placed in proximity to the crusher scraper which element, by means of inductance, magnetizes the scraper and the crusher roll upon which such scraper is operative so as to attract tramp iron to the crusher roll. It will be seen therefore that the principle upon which my invention is based differs from that heretofore relied upon by designers of magnetic tramp iron separators in that instead of endeavoring to extract the tramp iron from the crushed sugar cane mat by pulling the pieces of iron or steel from the blanket of cane as it passes from the crusher roll to the mill, I provide a magnetic tramp iron collector which exerts its energy in magnetizing the

lower crusher roll scraper and pulls the tramp iron away from the crusher roll over the scraper plate operative thereon to a field wherein the effect of the magnet is strongest so as to hold the separated pieces of iron in such field without interfering with the operation of the mill.

An important feature of my invention is the use of a magnet of novel construction and having a cooling system making the apparatus practicable for use in continuously operating sugar cane mills so that it is not necessary to shut down the mill periodically for a sufficient length of time to give the tramp iron separator an opportunity to cool.

In the accompanying drawings, in which a specific embodiment of my invention is illustrated, Fig. 1 is a fragmentary vertical section of a cane crushing apparatus equipped with my novel tramp iron collector; Fig. 2 is a section on the line 2—2 of Fig. 1 with portions of the apparatus omitted for purposes of clarity; Fig. 3 is a plan view of the magnetic collector showing the disposition of the magnetic coils therein; Fig. 4 is a vertical view, partly in section, of the magnetic collector taken on the line 4—4 of Fig. 3; Fig. 5 is a vertical section through the magnet coil and the magnetic scraper; Fig. 6 is an enlarged detail of the contactor between the magnetic scraper and the magnet box cover plate; Fig. 7 shows a general wiring diagram for the magnetic coils constituting elements of the tramp iron collector.

Referring more particularly to the drawings, in which similar reference characters identify similar parts in the several views, the cane crusher of usual construction is mounted upon frame 10 and consists of rotatable crushing rolls 11 and 12 which rotate in the direction of the arrows indicated in Fig. 1 having passed between them the mat of sugar cane for the purpose of crushing the same. The crusher rolls are revolved by the usual gears 13, each roll being provided with peripheral ribs or grooves 14.

Below the crusher rolls is the first of a series of mills, each of which comprises a set of closely set rolls 15, 15, between which the crushed cane is passed.

The upper crusher roll 11 is provided with the usual scraper 16 supported upon the end of a lever 17 secured to a turnbuckle 18. The general construction of the crusher rolls, the mill and associated mechanism, forms no part of the present invention and will therefore not be described in detail.

The lower crusher roll 12 is, in accordance with my invention, provided with a scraper tip 19, magnetized as hereinafter described. Such scraper tip forms an extension of a non-magnetic scraper plate 20 having inlaid strips 21 of iron or other magnetic material forming extensions of pole pieces positioned over the upper row of pole cores of the electromagnetic device located between the lower crusher roll and the first mill. The scraper plate 20 is secured upon a shaft 22 within bearings 23.

The electromagnetic device comprises a series of electromagnets having a series of pole shoes disposed as illustrated in Fig. 2 and is housed within a magnet box 24 of a non-magnetic material. Such electromagnets, as shown in enlarged sectional detail in Fig. 5, are mounted upon a base 25 to which is welded or cast integrally a yoke 26. Each magnet comprises a pair of iron cores 27 having coils 28 wound on fibre cylinders surrounding the cores, the iron cores being fastened to the yoke by means of bolts 29. A cork gasket 30 serves to keep the magnet box closed and tight, bolts 31 being used to secure the magnet box proper to the yoke 26.

Forming a cover for the magnet box within which the magnet coils are arranged is a thin brass cover plate 34 which is preferably secured by electric welding to the upper walls thereof, thereby forming a fluid-tight closure. Overlying the cover plate 34 is a surface plate 32 of non-magnetic material, for instance, copper, brass, mica, or a phenolic condensation product, over which the cane passes after leaving the crusher. The surface plate 32 is fastened to the magnet box by means of bolts 33, and is provided with suitable openings into which inserts 35 of iron or other magnetic material are welded so as to be positioned over the electromagnetic pole cores of the upper row of core pieces. A similar series of magnetic inserts 36 is placed over the lower row of magnetic pole cores.

With this pole arrangement, the magnetic lines of force produced by the electromagnet extend upwardly through and against the flow of cane from the upper row of poles and attract stray iron. The magnetic lines of force produced by the lower row of magnets extend upwardly across the gaps between the inserts and parallel with the line of the poles; in part they flow through and are concentrated in an iron tip 37 which extends from the lower edge of the non-magnetic face plate 32. This iron tip is so shaped that its lower side forms a flat horizontal surface 38 acting as a shelter for such small iron pieces as by reason of their mass or shape cannot absorb enough magnetism to withstand the downward push of the cane as it slides over the pole surface. In the operation of my device such small iron parts, usually of cylindrical or spherical shape, are pushed around the lower edge of the magnet plate and are found suspended from the horizontal surface 38 of the iron tip 37. It is also a function of the iron tip 37 to prevent magnetic lines of force from straying in the downward direction.

A retaining bead 39 may be advantageously placed along the upper edge of the iron tip 37 for the purpose of stopping and retaining stray iron. A similar retaining bead 40 may be provided substantially intermediate the width of the electromagnetic device and running the entire length of the plate 32.

My novel tramp iron collector apparatus is, as heretofore pointed out, designed for the continuous operation of the sugar cane mill to which it is applied. It is obvious that such a tramp iron collector and particularly the electromagnet become heated to a high degree during their operation. I have therefore designed my electromagnet to include a cooling system in which the cooling agent may be oil, air or other suitable medium. In the form of the invention shown in Fig. 5, the magnet box is provided with inlets 41 through which a liquid cooling agent, such as transformer oil, is pumped. From such inlets, one of which is located near each end of the lower side of the magnet box, in proximity to its base, the cooling agent passes between the coils, absorbing sufficient heat therefrom to cool the magnet, and leaves the box through outlet 42 located in the center of the upper portion of the box immediately below the non-magnetic cover plate 32. From such outlet, the cooling agent is passed into a cooling tank from which it is again pumped to the inlets 41. It will be noted from Fig. 5 that sufficient space is left between the

iron cores and the coils thereof to permit the free circulation of cooling agent about such cores and from one compartment of the box to the other. The cork gasket 30 and cover plate 34 are effective to keep the magnet box substantially fluid-tight.

Immediately below the electromagnetic box is positioned a chute 43 of brass or other non-magnetic material over which the cane passes on its way into the first of the series of mills 15.

Between the electromagnet box 24 and the lower crusher roll and depending from such box, is a splash plate 44, the curved upper portion 45 of which is made of brass, the remainder of such splash plate being of iron.

The scraper plate of the lower crusher roll, illustrated in enlarged detail in Fig. 5, has fastened to its upper end, by means of bolts 46, the scraper tip 19 heretofore described which has a serrated edge so that the points thereof fit into the grooving of the lower crusher roll 12, thereby making a sliding contact with said roll. As the scraper tips become worn, the scraper plate to which they are secured, is adapted to be turned about the shaft 22 by means of the turnbuckle 47 illustrated in dotted outline in Fig. 1. This turnbuckle arrangement is of the usual construction and forms no part of the present invention. It is effective to revolve the shaft 22 within the bearings 23 by means of levers 48, 48 at the end of said shaft so as to keep the scraper plate tips in sliding contact with the lower crusher roll at all times during the operation of the apparatus.

At the lower end of the scraper plate, such plate is provided with iron strips 21 which are inlaid into the non-magnetic scraper plate 20, the lower ends of the iron strips being in contact with the magnetic inserts in the cover plate 32 of the magnetic box 24 which are in turn in contact, at their bottom faces, with the iron cores of the magnet. In order to effect the continuous contact of the iron strips 21 of the scraper plate 20 with the magnetic insert 35 of the cover plate 32, I provide each iron strip 21 with a contact element 49, pivoted at 49' below each insert 21, a compression spring 50 being effective to keep each element 49 in contact with the magnetic inserts 35 in cover plate 32. In this manner, the plates 21, inlaid into the scraper plate, form extensions of the iron cores of the upper row of magnets which extend close to the lower part of the scraper point and, by means of inductance, highly magnetize such member as well as the lower crusher roll.

As shown in Fig. 2, the scraper point 19, the magnetic strips 21 and the non-magnetic scraper plate 20 are held together by means of brass bolts 46, and the scraper plate and magnetic strips by bolts 51. The assembled scraper unit thus formed is fastened to the scraper shaft 23 by means of brass bolts 52.

Turning now to a description of the electromagnetic device illustrated in enlarged detail in Figs. 3 and 4, the pole surface plates 35 and 36 constitute inserts over the electromagnetic pole cores of both the upper and lower rows, such pole surface plates being marked N and S to indicate their polarity as produced by the magnetic pole cores over which they are positioned. The magnetic circuit thus produced goes from an N pole through the insert 35 in the non-magnetic surface plate 32 then through contact element 49 and through the inlaid magnetic strip 21 of the non-magnetic scraper plate 20. As each N core is connected with an S core by means of a yoke 26, the magnetic flux of opposite polarity is conduced through the adjacent insert 35 in the non-magnetic surface plate 32 then through a contact element 49 and through adjacent iron strip 21 inlaid in the non-magnetic scraper plate 20, and hence the N inlaid strip and the S inlaid strip magnetize the scraper point and crusher roll by inductance. The magnetic circuit is similar for all the other scraper inserts.

The wiring diagram for the electromagnetic element of the tramp iron collector is illustrated in Fig. 7. All of the coils of the magnet are wound in the same direction, i. e. clockwise from the core out, but, as the reversal of the flow of current through a coil effects a reversal of the induced magnetic flux, the different cores can be given the polarities indicated in Fig. 7.

The tramp iron collector hereinabove described and as illustrated, contains 12 coils or electromagnets. The size of these coils depends upon the capacity of the mill in tons of sugar cane crushed per hour. As the tramp iron collector is placed in the chute over which the crushed cane passes from the crusher rolls to the mill, and the length of the rolls depends upon the capacity of the mill, the width of the collector depends upon the width of the chute. If the chute is narrower, the size of the coils may be smaller. Obviously, depending upon the shape of the coils, their number may be varied, their size also varying with the ampere turns required to produce the desired amount of magnetic flux. While in the illustrated embodiment of my invention, the coils are positioned in staggered relation, it is obvious that they may be arranged in a variety of ways, the arrangement of the pole shoes being optional. For instance, as the arrangement of the magnetic poles is to be such that a virtual net of magnetic lines is created to draw stray iron to the face plate and to hold it solidly thereagainst, instead of the magnetic lines of force extending upwardly through and against the flow of cane from the upper row of poles as is produced by the described arrangement of the magnetic poles, the magnetic lines of force may be produced so as to be in line or parallel with the chute or the flow of cane. All poles of the same polarity may therefore be placed in line transverse to the flow of cane, in which case two inserts, each extending lengthwise across the magnet face plate, would form two pole shoes of a united magnet. Other methods of arranging the poles may be resorted to, for instance, alternating the pole faces in which case part of the magnetic lines of force would extend transverse to the flow of cane and part parallel with the flow of cane.

Although in the illustrated embodiment the inserts of pole shoes are shown as being rhomboidal, it will be obvious that these pole shoes may be made of any shape or form without departing from the invention.

It will also be obvious that the gaps of non-magnetic material between the pole shoes may be varied according to the magnetic forces created by the ampere turns of the magnetic coils. These gaps form an important feature of the apparatus as they provide places where stray iron may be held.

To remove the tramp iron which has been collected from the material passing through the apparatus, the collector is temporarily demagnetized. This interruption in the operation of the apparatus, however, is of extremely short

duration to afford the short period of time necessary for removing the collected tramp iron.

While my novel tramp iron collector has been described and illustrated as applied to a sugar cane mill, it is obvious that it may be used in installations, other than sugar cane apparatus, where the problem of separating tramp iron from the material being treated, is presented.

I claim:

1. In combination with a cane crushing apparatus having a pair of rolls provided with peripheral grooves and a mill, a tramp iron collector comprising an electromagnetic device positioned at a point between the crusher rolls and the mill, a non-magnetic cover plate for said device having a plurality of recesses, inserts of a magnetic material positioned within said recesses in said cover plate, a scraper plate having a scraper tip adapted to enter the grooves of the lower crusher roll, and a plurality of strips of magnetic material upon said scraper plate forming extensions of the inserts of magnetic material over the non-magnetic cover plate of the electromagnetic device.

2. In combination with a cane crushing apparatus having a pair of rolls provided with peripheral grooves and a mill, a tramp iron collector comprising an electromagnetic device positioned at a point between the crusher rolls and the mill, a non-magnetic cover plate for said device having a plurality of recesses, inserts of a magnetic material positioned within said recesses in said cover plate, a scraper plate having a scraper tip adapted to enter the grooves of the lower crusher roll, a plurality of strips of magnetic material upon said scraper plate forming extensions of the inserts of magnetic material over the non-magnetic cover plate, said non-magnetic cover plate having an iron tip extending from the lower edge thereof and shaped to have its lower side form a flat horizontal surface.

3. In combination with a cane crushing apparatus having a pair of rolls provided with peripheral grooves and a mill, a tramp iron collector comprising an electromagnetic device positioned at a point between the crusher rolls and the mill, a non-magnetic cover plate for said device having a plurality of recesses, inserts of a magnetic material positioned within said recesses in said cover plate, a scraper plate having a scraper tip adapted to enter the grooves of the lower crusher roll, and a plurality of strips of magnetic material upon said scraper plate forming extensions of the inserts of magnetic material over the non-magnetic cover plate of the electromagnetic device, whereby the scraper tip and the lower crusher roll are magnetized, said cover plate having a retaining bead substantially intermediate the width of the electromagnetic device and running the entire length of said cover plate.

4. In combination with a cane crushing apparatus having a pair of crusher rolls and a mill of closely set cylinders, a tramp iron collector comprising an electromagnetic device placed intermediate said crusher rolls and mill, in the path of travel of the cane being acted upon by the apparatus, said electromagnetic device comprising a magnet box, a plurality of electromagnetic coils in said box disposed transversely of the flow or travel of the cane, a nonmagnetic cover plate for said box, a plurality of inserts of magnetic material in said cover plate positioned over the coils of said electromagnet and a pivoted scraper plate of nonmagnetic material, a plurality of strips of magnetic material inlaid into said scraper plate and forming extensions of the magnetic inserts positioned over the row of coils of the electromagnetic device, and a scraper tip having a serrated edge the points thereof being adapted to fit into the grooving of the lower crusher roll, thereby making a sliding contact therewith.

5. A pivoted scraper plate for use with the combination claimed in claim 4, provided with a plurality of strips of magnetic material inlaid into the non-magnetic scraper plate, the lower ends of the strips being in contact with the magnetic inserts in the cover plate of the magnet box, such magnetic inserts in the cover plate being in turn in contact with the cores of the electromagnet in said box.

6. The combination claimed in claim 1 in which the scraper plate is provided with a contact element pivoted below the scraper plate and having means effective to keep the contact element in contact with the magnetic inserts of the cover plate.

7. In combination with a cane crushing apparatus having a pair of crushing rolls provided with peripheral grooves, and a mill having contacting cylinders, an electro-magnetic device for collecting metallic foreign matter lodged in the material acted upon by the apparatus, said magnetic device being effective to magnetize the lower crusher roll of the cane crushing apparatus, and a magnetized scraper tip adapted to fit into the grooving of the lower crusher roll, thereby making a sliding contact therewith.

8. The combination claimed in claim 7, including a nonmagnetic cover plate for the electromagnetic device provided throughout its lower edge with an iron tip, magnetized so as to cause it to retain suspended therefrom small pieces of metallic foreign matter which by reason of their mass or shape cannot absorb enough magnetism from the electromagnet to withstand the downward push of the cane as it slides over the cover plate.

9. A tramp iron collector for cane crushing machinery, comprising an electromagnetic device having a plurality of coils positioned in staggered relation throughout the width of the path of the flowing cane, and means for effecting the magnetization of the lower crusher roll by induction from said electromagnet, said means comprising a nonmagnetic scraper plate, a plurality of strips of magnetic material distributed upon said cover plate so as to form extensions of the pole shoes of the electromagnetic device, and a scraper tip extending from the non-magnetic scraper plate and in contact with the peripheral surface of the lower crusher roll.

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