Aug. 18, 1942. A. ROBERTS 2,293,664

MAGNETIC SEPARATOR

Filed May 6, 1939 2 Sheets-Sheet 1

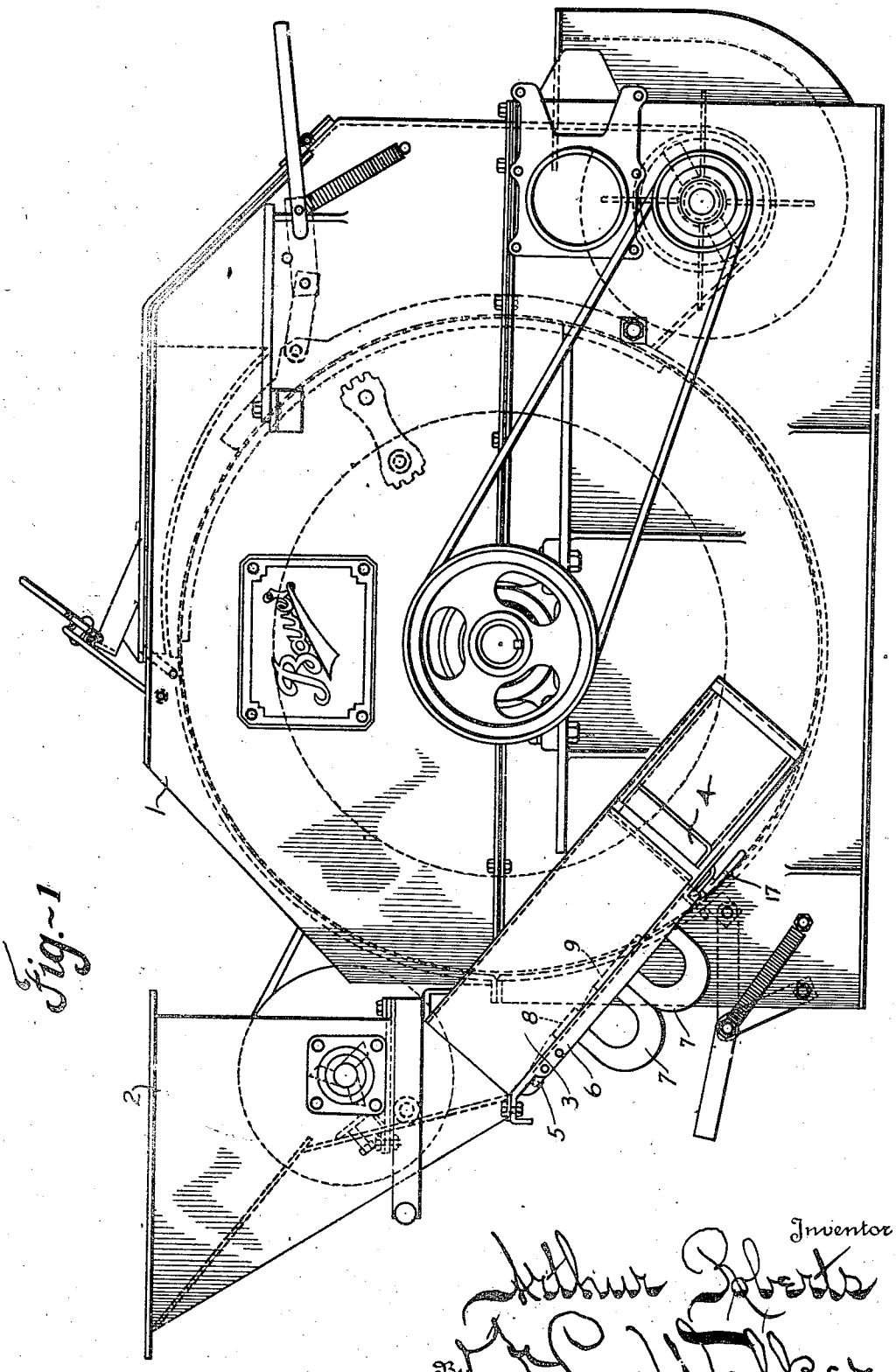



Fig. 1

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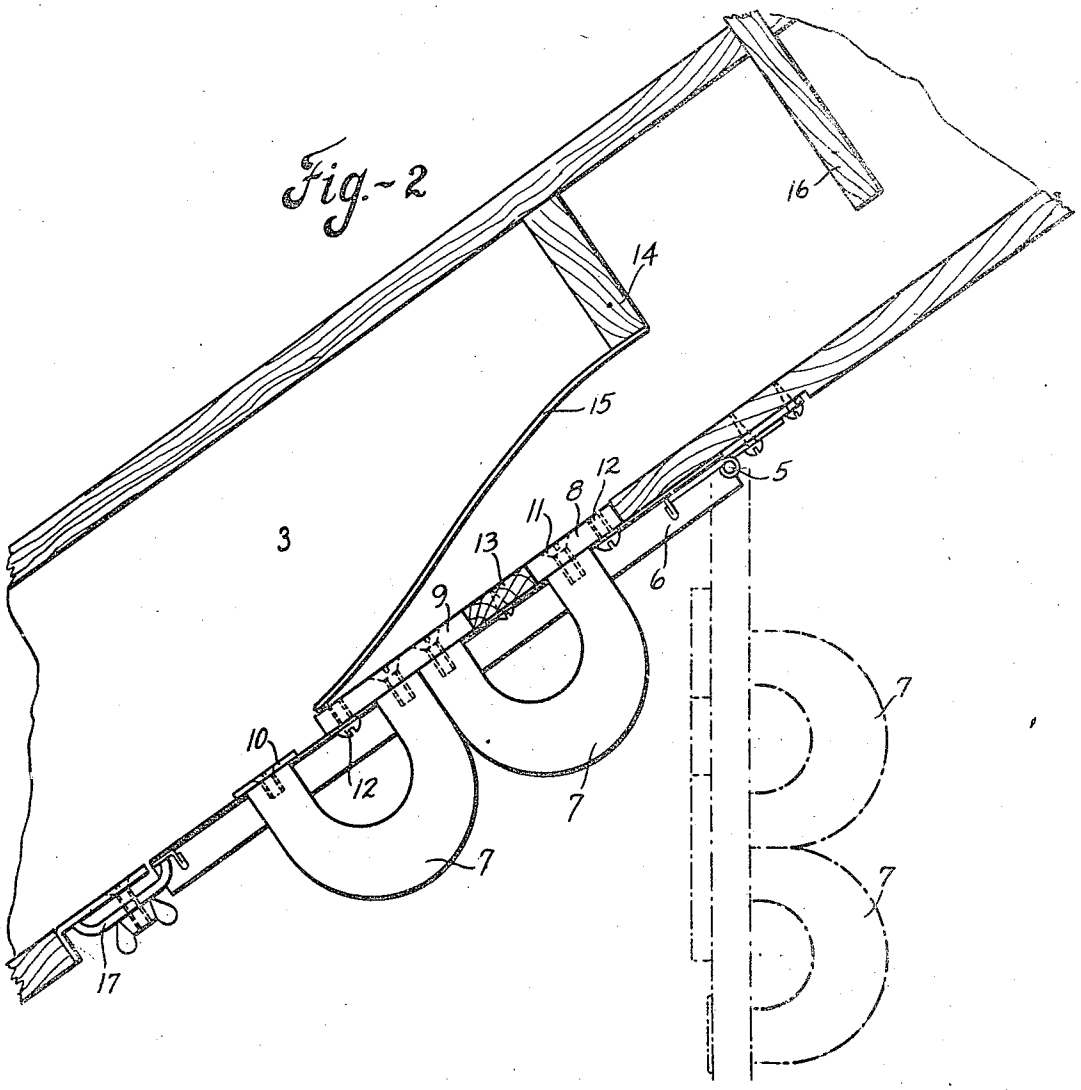



Fig.-2

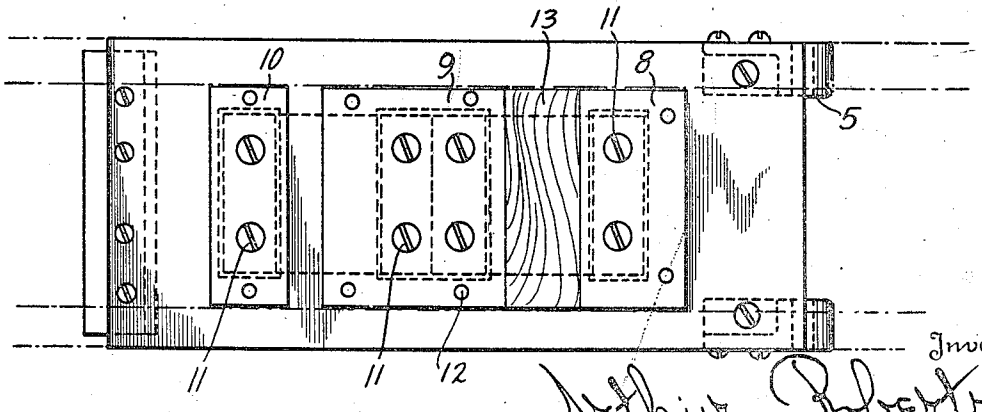



Fig.-3

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Patented Aug. 18, 1942 2,293,664

# UNITED STATES PATENT OFFICE

2,293,664

## MAGNETIC SEPARATOR

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Application May 6, 1939, Serial No. 272,159

2 Claims. (Cl. 209—223)

This invention pertains to hammer mills and the treatment of cereal grains preparatory to milling operations, and more particularly to a method of removal of stray bits of iron and steel such as nails, bolts, nuts and bits of scrap metal from a stream of grain while passing through a conveyor chute to a grinding mill, or into a vessel or car for shipment or a storage bin, and to a magnetic separator therefor.

It is not unusual for stray pieces of metal known as "tramp iron" to become entrained with grain while in shipment or in storage. Under suitable atmospheric conditions grain dust becomes explosive and inflammable. Metallic debris in the grain may not only cause serious damage to the mill, but by sparks incident to its passage through the mill may cause explosion and fire.

The use of electromagnets in the course of the grain involves certain disadvantages and undesirable features. The necessary electrical wiring and liability of short circuiting of the current is a constant source of danger of fire and explosions. Such electromagnets of suitable capacity are not only quite expensive but become totally inoperative upon interruption of the electrical current supply, which may be independent of the mill operating power. In such case the mill is without protection against tramp iron.

Insurance regulation necessitates with electromagnets provision of an automatic discharge door for collected metallic debris. In event of a blown fuse or other current interruption, the door drops and allows grain to be spilled. To obviate grain loss under such circumstances it is not unusual for operatives to prop the doors closed, contrary to insurance requirements. It is also found that such automatic outlets required with electromagnetic separators become clogged with dirt or dust lodged in the hinges or blocked by tramp iron held in the path of the door by residual magnetism. Permanent magnets have heretofore failed and have been condemned by insurance underwriters as being too weak and as likely to lose their magnetism.

To overcome the objectionable features of the devices heretofore used, there is contemplated in the present invention the use of artificial magnetic alloys formed into permanent magnets of high power and so disposed as to provide successive magnetic fields of different characteristics through which the grain passes to a mill or other delivery destination.

The object of the invention is to provide a magnetic separator for tramp iron which will be simple in construction and which may not only be economically manufactured, but will be more efficient in use, automatic in action, uniform in operation, having minimum parts, and unlikely to get out of repair.

A further object of the invention is to provide permanent magnets for separator purposes having high power and arranged in tandem succession in such relation as to afford magnetic fields of different extent and of different intensity.

A further object of the invention is to adapt commercial high power magnet alloy materials to the present purpose.

A further object of the invention is to provide a magnetic separator having the advantageous structural features and inherent meritorious characteristics herein mentioned.

With the above primary and other incidental objects in view, as will more fully appear in the specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation, or their equivalents, as hereinafter described or illustrated in the accompanying drawings.

In the drawings, wherein is shown the preferred but obviously not necessarily the only form of embodiment of the invention,

Fig. 1 is a side elevation of a conventional form of hammer mill to which the present magnetic separator apparatus has been applied.

Fig. 2 is a longitudinal sectional view through a portion of the grain chute and through the magnetic separator.

Fig. 3 is a plan view of the magnetic separator assembly.

Like parts are indicated by similar characters of reference throughout the several views.

While for illustrative purposes, but with no intent to unduly limit or restrict the scope or application of the invention it is herein shown applied to a typical form of hammer mill, it is to be understood that the separator is not limited thereto but is applicable to grain chutes and to conveyors for other materials generally apart from any mill, and for treatment of other than grain.

Referring to the drawings, 1 is a typical hammer mill for grinding grain supplied thereto through a feeder 2, which may also operate to preliminarily crush the material. From the feeder 2 the grain flows through the inclined chute 3 to the mill 1. The chute is provided with an air inlet 4 through which air is admitted to the mill.

Located on the underside of the chute, in position to be traversed by the flow of grain, is the magnetic separator unit. This unit preferably, although not necessarily, is mounted for downwardly swing movement about a hinge connection 5 as shown by dotted lines in Fig. 2.

The magnetic unit comprises a frame 6, which forms a continuing portion of the bottom of the inclined chute 3 in which are mounted a pair of permanent magnets 7—7. While but two magnets are illustrated, a greater number may be employed. For some conditions of use, a single magnet of proper power may be sufficient.

There are now commercially available several different magnetic alloys which afford permanent magnets of quite high power. The preferred material adopted for the present purposes, but not necessarily the only usable alloy, is one having the characteristics of high coercive force, with low residual induction, affording a maximum available energy at a low flux density and a high demagnetizing force, which enables use of magnets of relatively small size. Mechanically such alloy is of a relatively low density, weighing approximately a quarter pound per cubic inch, and is somewhat brittle, having a comparative high coefficient of thermal expansion. Such alloy is cast to desired shape and finished by grinding with cored holes or with soft steel inserts cast therein for fastening purposes.

Two of the horseshoe type magnets 7 are disposed in tandem aligned relation longitudinally of the chute 3 with their like poles adjacent. That is to say, the medial poles of the pair of magnets 7 are both positive or both negative and the extreme poles are of opposite characteristic. In practice the horseshoe magnets 7 are abutted together with their positive or north poles in contact with each other. Thus the pair of horseshoe elements become in effect a single permanent magnet. The magnetic elements 7 are relatively thick or wide transversely of the chute, and are provided with attached pole pieces 8, 9 and 10 which extend substantially the full width of the chute passage. The medial pole piece 9 is relatively large and is common to both the magnet members 7 and is attached to the abutting poles of both magnets. It is unsymmetrically disposed relative to the associated poles of the respective magnets 7, whereby it projects in the direction of travel of the grain a considerable distance across the space between the poles of the second magnet 7 and a much lesser distance transversely of the space between the poles of the other magnet. As result, there is afforded a much wider gap between the pole pieces 8 and 9 of the first magnetic element 7 than between the pole pieces 9 and 10 of the succeeding such element. The pole pieces are fixedly attached to the poles of the magnets 7 by screws 11 and are further attached to the frame 6 by screws 12. The final pole 10 of the second magnet 7 (in the direction of flow of grain) is of less thickness and there is a comparatively narrow gap between this pole piece and the intermediate pole piece 9. The gap between the pole pieces 8 and 9 is filled by a wood strip 13 or a filler of other non-magnetic material. However, since the final pole piece 10 is relatively thin, affording little or no obstruction to the flow of grain, a filler body is deemed unnecessary, it being understood that the unit 6 extends across and fills the space between the magnet poles. The disposition and relation of the pole pieces by which relatively wide initial air gap is provided between the pole pieces 8 and 9 affords a relatively large magnetic field, effective quite a distance above the pole pieces. This tends to attract the more distant tramp iron passing over the unit and materially reduces its velocity. The stray metal after passing the first magnet position will be travelling in a plane so close to the magnet faces and at such a low velocity that it will be caught and securely held by the second magnet, the field of which is less extensive but of greater intensity.

Disposed transversely of the upper portion of the conveyor chute adjacent the upper end of the magnetic separator unit is a baffle 14, from the lower edge of which extends in the direction of grain flow a flexible guide leaf 15 beneath which the stream of grain flows freely. The baffle and associated flexible guide leaf tends to level the flowing grain and to restrict it to a comparatively shallow stream, so that any entrained tramp iron is necessarily brought well within the magnetic fields of the respective magnets and within their range of influence.

A cut-off slide or regulatory damper 16 is shown in the chute 3, Fig. 2, immediately above the position of the magnetic separator. The separator unit is normally maintained in closed relation, aligned with the underside of the chute by any suitable clamp or fastening device such as is shown at 17. Upon releasing the fastener 17 the entire unit may be swung downward to the dotted line position for removal of adhering metal pieces by hand picking.

The separator unit may be incorporated in any chute or associated with any conveyor for transportation of not only grain, but any other materials not subject to magnetic attraction for the removal of bits of "tramp iron" therefrom.

By the use of an artificial magnetic alloy of the character described, the size and weight of the magnets is very materially reduced and their efficiency greatly increased. They obviate the dangers of fire and explosion, incident short circuiting of electromagnets, and breaks in the energizing circuits.

It is suggested that a commercial magnetic alloy which amply meets the present requirements is that introduced by the General Electric Company and identified by the trade name "Alnico."

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise the preferred form of several modes of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

Having thus described my invention, I claim:

1. The combination with a conveyor chute for grain or the like to be cleared of tramp iron, of a swinging magnetic separator unit in contiguous relation to which the material is caused to pass, including plural U shaped permanent magnets disposed with like legs thereof in contacting re-

lation whereby the plurality of magnets become in effect a single multipole magnet, a pole piece common to like poles of different magnets and additional pole pieces of opposite polarity in differently spaced relation with the common pole piece, with resulting magnetic fields of progressively decreasing extent and proportionately increasing intensity.

2. In a magnetic separator of the character described, an inclined chute including a hinged portion therein supporting a plurality of permanent U shaped magnets disposed in tandem relation, with legs of like polarity of different magnets in contacting relation whereby succeeding magnets become in effect a single multipole magnet, pole pieces common to the contacting legs of like polarity of different magnets and pole pieces common to the contacting legs of like opposite polarity of the different magnets and additional pole pieces pertaining to the terminal legs of the plurality of magnets, disposed in progressively decreasing spaced relation, thereby providing a plurality of magnetic fields of progressively decreasing extent and proportionately increasing intensity.

ARTHUR ROBERTS.