July 14, 1936. C. C. INGRAHAM 2,047,508

GRAIN SEPARATOR

Filed Aug. 7, 1933 3 Sheets-Sheet 1

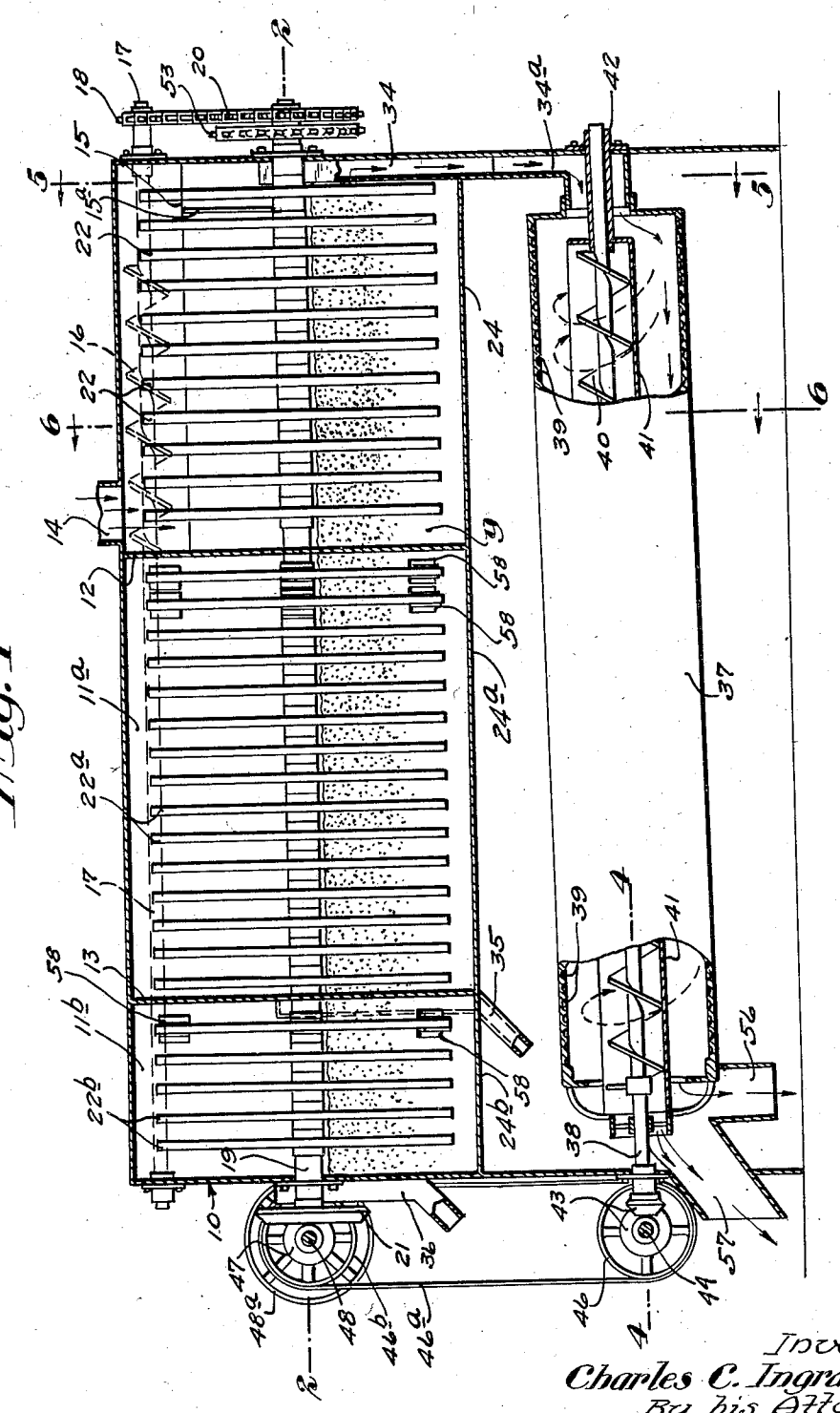


Fig. 1

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Fig. 2

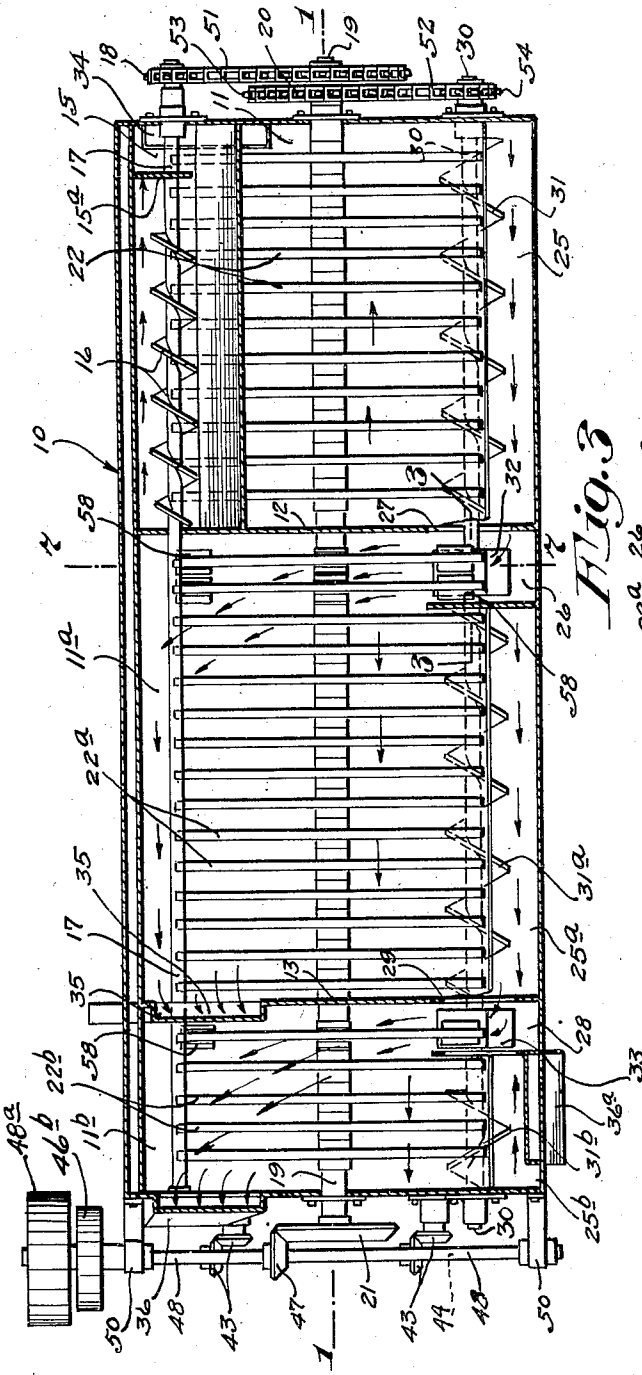
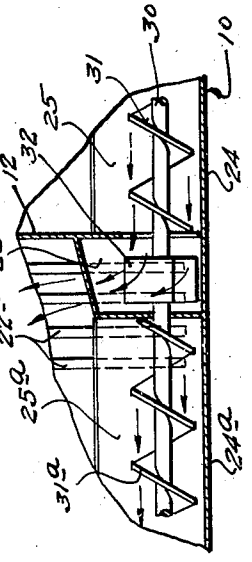


Fig. 3



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Fig. 4

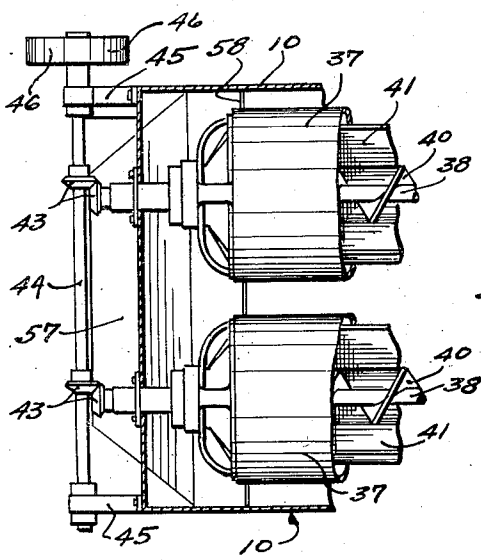


Fig. 5

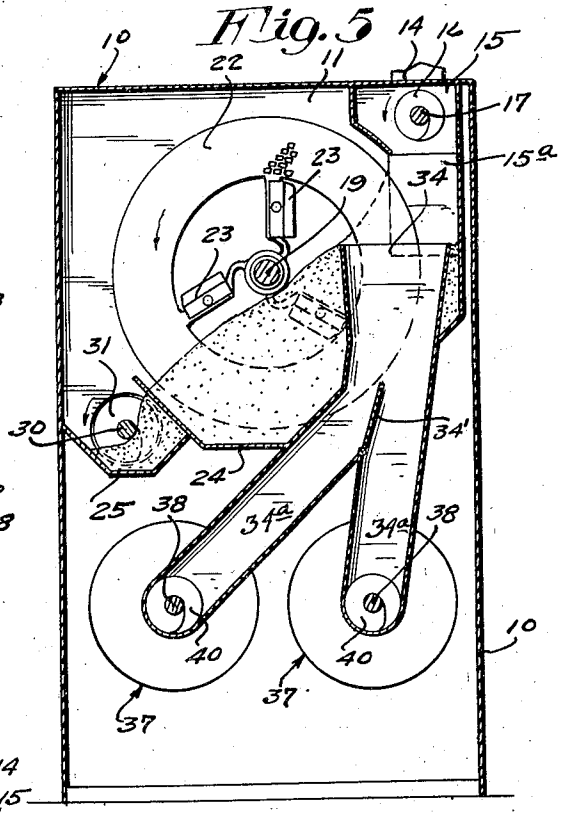


Fig. 6

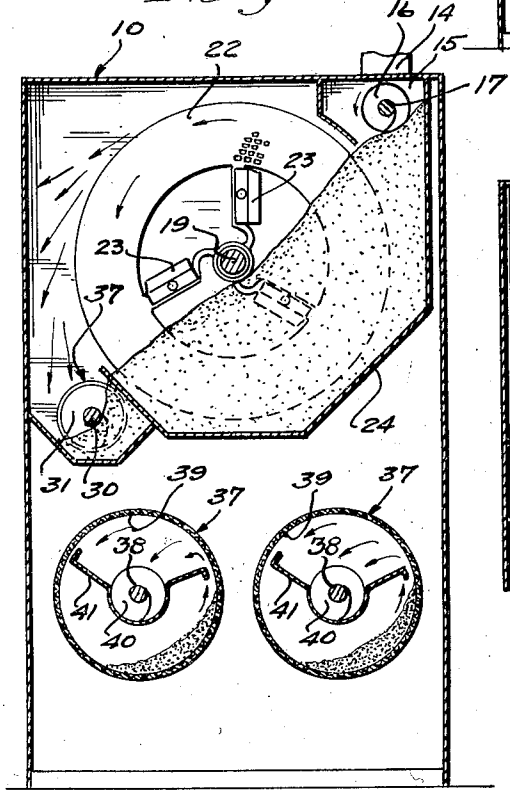
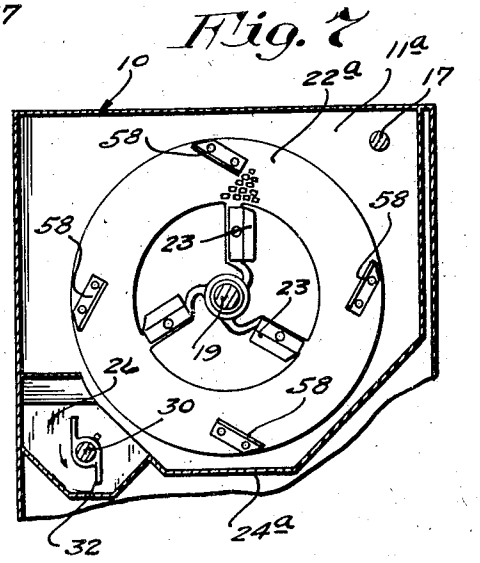


Fig. 7



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Patented July 14, 1936

2,047,508

UNITED STATES PATENT OFFICE

2,047,508

GRAIN SEPARATOR

Charles C. Ingraham, Minneapolis, Minn., assignor to Hart-Carter Company, Peoria, Ill., a corporation of Delaware

Application August 7, 1933, Serial No. 684,017

10 Claims. (Cl. 209—96)

My invention provides an improved machine or apparatus for the separation of different kinds of grain and for the separation therefrom of small seeds. Generally stated, the invention consists of the novel devices, combinations of devices and arrangement of parts hereinafter described and defined in the claims.

It is thought that the combination or relative co-operative construction and arrangement of the several separating instrumentalities will be made salient by the following introductory discussion of the relative merits, for somewhat different kinds of separation, of pocketed or indented separating discs and pocketed or indented separating drums.

As illustrative of the type of separating discs herein referred to, attention is called to the Carter Patent No. 1,364,247 of January 4, 1921; and as illustrative of the general type of separating drum herein referred to or that may be employed, attention is called to the Mjolsness Patent No. 1,625,008, of April 19, 1927.

In the indented drum or cylinder, centrifugal force plays a greater part in making the separation than it does in the case of disc separation. Because of this fact, there are certain separations which can be more effectively made by one or the other of the two principles, according to various factors, such as what the materials may be and what separation may be desired.

To illustrate this point, we might make a comparison in the separation of certain materials: It may be desired to separate oats and barley from wheat; and we will say that the wheat is in the majority as to quantity. Experience has shown that a disc separator with pockets of a size suitable for the separation will make a more accurate separation of the wheat from the oats and barley than can be done by an indented cylinder machine. The kernels of grain are more definitely measured by the pockets of the discs, and the kernels of barley and oats, being longer than the wheat kernels, are not picked up by the pockets of the discs.

If the same separation of this same material is attempted by means of an indented cylinder having pockets of comparable size, it will be found that more barley kernels will be lifted by the indented cylinder pockets and discharged with the wheat kernels than was the case in the disc separator. The pockets of the indented cylinder do not measure as accurately as to length.

Because of these characteristics in the two different systems, each system has advantages over the other in certain separations. Just as an indented cylinder will not make as close a length separation as the disc separator but, as mentioned above, in a particular instance would tend to lift more barley in the pockets rather than reject it with the oats, it is more adaptable for making a separation of oats from barley. Consequently, it is finding more and more favor in barley cleaning operations—particularly in the malting industry.

To state it briefly, indented cylinders will make a more complete separation of oats from barley than will disc separators even though there may not be a very great difference in the length of the two varieties of grain. By the same token, indented cylinders will not make as complete separation of barley from wheat as will disc separators. Neither will they make as complete a separation of small seeds from wheat or from barley or oats as will disc separators.

In speaking of the separation of fine seeds from grains by the two methods, we should mention that a more precise measuring method is required than in the separation of, for instance, barley and oats; and this exactitude in measuring the sizes of the seeds and grain kernels is more effectively done by the discs than by the cylinders. Experience has shown that disc separators will more effectively separate grains than cylinders in practically every required separation with the exception of that of barley and oats—in which separation the indented cylinders seem to excel.

To illustrate how a combination machine of this kind might be of more value in the cleaning of various grains than either a disc separator or a cylinder separator, we may consider a machine such as I have here illustrated for use in a country elevator. Let us say that there will be required the cleaning of hard spring wheat, removing therefrom oats, wild oats, barley, also small weed seeds such as wild buckwheat, ball mustard, cockle and various other small weed seeds. Also, the machine will be used for the cleaning of large varieties of wheat such as durum, in which case the size of the wheat kernels will more nearly approach the size of the other grains which are to be removed, such as barley and oats. The durum wheat will also contain small weed seeds which will have to be removed.

Let it be assumed that the machine is also to be used for cleaning barley, removing from the barley, oats as well as small weed seeds.

In the first requirement mentioned—that of cleaning the hard spring wheat—a disc separator will be entirely suitable, and in fact excel in quality of work any other machine now on the

market. In the second requirement—that of cleaning durum wheat—the same thing holds true as to the superiority of the disc separator.

If a straight cylinder machine were used on the two separations mentioned, the removal of the oats and wild oats from the wheat would be satisfactory; but in a case where wheat contained barley, the barley would not be removed from the wheat nearly so well as it would be by means of disc separation.

In the removal of the small weed seeds from either the hard spring wheat or the durum wheat, experience has shown that the discs make the separation much more efficiently than cylinders, both from the standpoint of the cleanliness of the wheat and from the standpoint of the less waste of small wheat with the weed seed dockage.

In mentioning the small seed separation from grains, it might be well to remark on the difficulty found in attempting to remove small round seeds from grains by means of cylinders. Round seeds such as ball mustard and wild peas cannot be as effectively removed by cylinders as by discs because of the fact that the round seeds tend to roll out of the indented cylinder pockets before being carried high enough to be discharged into the trough. This difficulty is not encountered in the disc method as the undercut pocket of the disc holds the round seed and carries it up to be discharged with the fine screenings.

To go on with the illustration respecting a country elevator machine, we will say that in the attempted cleaning of barley on this machine a straight disc separator, if the machine were such, would not make a good clean-cut separation of the oats from the barley, and it would be found that too large a quantity of barley would pass off with the oats. This would naturally happen inasmuch as a disc separator fitted with discs for country elevator work would, as has been shown, reject barley from wheat better than a cylinder machine would do. It is only logical, therefore, that it would reject barley with the oats when cleaning barley.

The cylinder, on the other hand, while not doing as well on cleaning wheat, will when it comes to cleaning barley, excel the work of the disc separator because of its ability to remove oats from the barley without the loss of much barley.

In my improved machine, I have combined pocketed discs and pocketed drums or cylinders in such way that the two types of the pocketed separating devices simultaneously perform the functions for which they are best adapted. The pocketed discs are arranged in groups with the pockets of the discs of different groups of such size as to accomplish different kinds of grades of separation; means is provided for delivering to certain of the groups of pocketed discs, that part of the grain that can best be separated by such drums; and these several instrumentalities together with their driving mechanisms, and cooperating elements, are combined in a complete or self-contained machine.

In the accompanying drawings, which illustrate a commercial form of the improved machine or grain separator, like characters indicate like parts throughout the several views.

Referring to the drawings:

Fig. 1 is a view through the complete machine taken in section on the line 1—1 of Fig. 2, some parts being shown in full;

Fig. 2 is a horizontal section taken on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary vertical section taken approximately on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary section taken approximately on the line 4—4 of Fig. 1, some parts being shown in full and some parts being broken away;

Fig. 5 is a transverse vertical section taken on the line 5—5 of Fig. 1;

Fig. 6 is a transverse vertical section taken on the line 6—6 of Fig. 1; and

Fig. 7 is a transverse vertical section taken on the line 7—7 of Fig. 2.

In this commercial form of the improved machine illustrated in the drawings, the several separating elements and immediately co-operating parts are shown as mounted within a rectangular sheet metal housing **10**. The upper portion of this housing is divided into several compartments, to wit: as shown, into three separating compartments **11**, **11a** and **11b** by means of transverse vertical partitions **12** and **13**. The commingled stock to be separated is delivered to the compartment **11** through a suitable spout **14** that delivers directly into a distributing hopper **15** that is open at its bottom and, as shown, extends from end to end of the compartment **11**. A spiral distributing conveyor **16** is arranged to work in the distributing hopper **15** immediately above the open bottom thereof. This conveyor **16** is shown as carried by a long shaft **17** extended completely through the housing **10** and provided at one end with a sprocket **18**.

Extended longitudinally and completely through the housing **10**, and journaled in suitable bearings thereon and on the partitions **12** and **13**, is a shaft **19** shown as provided at the head end of the machine with a sprocket **20** and at its rear end with a beveled gear **21**. In this preferred form of the machine the shaft **19** carries three groups of pocketed separating discs **22**, **22a** and **22b**, the said groups of discs being located, respectively, in the compartments **11**, **11a** and **11b**. The pockets in these discs are preferably formed substantially as illustrated in my prior Patent No. 1,665,549 of April 10, 1928. However, the pockets in the discs **22** are larger than the pockets in the discs **22a** and the pockets in the discs **22a** are larger than the pockets in the discs **22b**. In practice I have found that in many instances, the spiral conveyor **16** and shaft **17** may be dispensed with and gravity relied upon to properly distribute the grain within the distributing hopper **15**. Whether or not this conveyor is employed, I have found it an advantage to place a baffle plate **15a** near the delivery end of said hopper so as to cause the grain to bank up on the discs **22** to approximately a constant level.

The discs **22**, **22a** and **22b** have large axial passages, and in fact, are of annular form connected to hub structures by radial spokes equipped with beveled propelling blades or surfaces **23**. The discs, in the arrangement illustrated. will be driven in a counter-clockwise direction, in respect to Figs. 5, 6 and 7; and the cam blades on the spokes of the discs **22** are beveled in a direction to propel, the stock in a direction from left toward the right, in respect to Fig. 1, whereas the cam blades on the spokes of the discs **22a** and **22b** are beveled in a direction to cause the stock to move from right toward the left, in respect to Fig. 1, as will hereinafter more clearly appear.

The separating compartments **11**, **11a** and **11b**

are provided with hopper-like bottoms 24, 24ª and 24ᵇ that afford grain containers through which the lower portions of the respective discs are arranged to run. At one side, the hopper-like bottoms or containers 24, 24ª and 24ᵇ are cut low and arranged to overlie, respectively, catch troughs 25, 25ª and 25ᵇ. Between the catch troughs 25 and 25ª is an elevator pocket 26 into which the trough 25 delivers through an opening 27 in the partition 12; and between catch troughs 25ª and 25ᵇ is an elevator pocket 28 into which the trough 25ª delivers through an opening 29 in the partition 13. A long shaft 30 extends longitudinally through and is journaled in bearings on the housing 10 and carries spiral conveyors 31, 31ª and 31ᵇ arranged to work, respectively, in the catch troughs 25, 25ª and 25ᵇ. Shaft 30 is driven in a direction to cause the spiral conveyors 31 and 31ª to feed the stock or grain in a direction from right toward the left, in respect to Fig. 2. As shown, the spiral conveyors 31 and 31ª have a left-hand trend or thread while the conveyor 31ᵇ has a right-hand trend or thread so that the latter will force the grain delivered into pocket 25ᵇ not only toward the discharge spout 36ª, but toward the elevator pocket 28, causing a certain amount of grain to be redelivered to elevator 33.

The elevator pockets 26 and 28 are formed alike, see Fig. 7, and are arranged to direct the stock, respectively, into the hoppers 24ª and 24ᵇ. Shaft 30 within the pockets 26 and 28 is provided with paddle-acting elevator blades 32 and 33 which, under rotation of shaft 30 in the direction of the arrow marked on Fig. 7, will lift the stock and crowd the same into the communicating hopper.

The separating compartment 11 is provided at its front end with an overflow discharge spout 34, see Figs. 1 and 5; the separating compartment 11ª at its delivery end, to wit: at the partition 13, is provided with an overflow discharge spout 35, see Figs. 1 and 2; and the separating compartment 11ᵇ at its delivery end, to wit: at the rear end of the housing 10, is provided with an overflow discharge spout 36, see Fig. 1.

The overflow discharge spout 34 is arranged to deliver to one or more separating drums. In the preferred arrangement for co-operation with the group of discs 22, I have provided two such drums. These drums or cylinders 37 are located in the lower portion of the housing 10 just below the hoppers or containers 24, 24ª and 24ᵇ and are set in rearwardly inclined positions. These drums, by means of spider-like heads, are secured to and rotated with a shaft 38 suitably journaled at its ends in bearings on the ends of the housing 10. On its inner surface, the drum 37 is formed with pockets or indentations 39. These pockets and also the pockets of the above described discs are, of course, closely positioned on the entire separating surface of the said drums and discs.

Within the drums the shafts 38 carry spiral conveyors 40 that work in non-rotary catch troughs 41. These troughs 41 are loosely hung on rotary shaft 38 and are shown as provided with projecting sleeves 42, see Fig. 1, capable of being locked or held against rotation with respect to the shafts 38 and drums 37.

Catch trough 25ᵇ has a discharge spout or opening 36ª.

The spout 34 at the junction of its delivery branches, as shown, is provided with a pivoted gate 34' adapted to se set to properly distribute the grain to the respective branches and hence to the respective cylinders or drums.

For delivery from the overflow spout 34 simultaneously to the two drums, said spout 34 is provided with branches 34ª, see Figs. 1 and 5, which deliver directly into the receiving ends of the respective drums.

Shafts 38 are driven through intermeshing bevel gears 43 from a transverse shaft 44, see Figs. 1 and 4, journaled in suitable bearings 45 on the rear end of the housing 10. Shaft 44 also carries a pulley 46. The beveled gear 21 on the rear end of the disc-carrying shaft 19 meshes with a beveled pinion 47 on a transverse shaft 48, see Figs. 1 and 2, journaled in bearings 50 on the rear end of the housing 10.

A belt 46ª, see Fig. 1, runs over pulley 46 and over a pulley 46ᵇ on the upper shaft 48. As shown in Figs. 2 and 7, those discs 22ª and 22ᵇ that are respectively opposite the pockets 26 and 28, are shown as provided with circumferentially spaced lifting flights 58 that assist in carrying the grain from said pockets into the containers 24ª and 24ᵇ.

A sprocket chain 51 runs over the sprocket 20 on disc shaft 19 and over the sprocket 18 on the distributor shaft 17. Another sprocket chain 52 runs over a large sprocket 53 on shaft 19 and over a smaller sprocket 54 on conveyor shaft 30.

The driving connections described, while they may, of course, be varied, serve to drive the several running parts of the machine in the directions indicated or in the directions of the arrows marked on the several views. With the driving connections illustrated, power will be transmitted to the machine through a pulley 48ª shown as applied to the projecting end of the upper transverse shaft 48.

As best shown in Fig. 1, the lower ends of the drums 37 deliver to discharge spouts 56 while the lower ends of the troughs 41 deliver to discharge spouts 57.

Operation

As the first illustration of the operation of the machine we assume that the incoming stream of stock to be separated consists chiefly of wheat commingled with more or less oats, wild oats, possibly some barley and small seeds such as ball mustard, wild peas, wild buckwheat, and cockle. This commingled stream will be delivered through the spout 14 into the distributing hopper 15 and will be spread by the conveyor 15 or by gravity or both so that the containing hopper 24 will be kept filled with the commingled stock, substantially as best shown in Fig. 6.

By the relatively large pockets of the first group of pocketed discs 22, the majority of the wheat and all of the small seeds, consisting, for example, of seventy per cent of the main stream, will be picked up, carried over, and under the action of centrifugal force and gravity, will be delivered into the first catch trough 25 while some wheat and all of the oats and barley will be tailed over and delivered through spouts 34 and 34ª into the two separating drums 37. The wheat tailed over with the oats will, under the action of gravity, be dropped into the catch troughs 41 and under the action of the spiral conveyor 40 will be discharged through spout 57 while the oats will be tailed over from the lower ends of the drums 37 and discharged through spout 56.

In the use of the machine illustrated, I have obtained the best results with the separating discs

driven approximately sixty R. P. M. and the cylinders driven at approximately 56 R. P. M.

The main body of wheat commingled with the small seeds, such as noted, will, as stated, be delivered into the catch trough **25**. This commingled material by the feed screw **31** to be delivered into the pocket **26** and by the paddle-acting elevator **32** will be delivered into the second containing hopper **24a**. By the pockets of the second group of discs **22a** all of the small seeds and small materials, such as broken wheat and small wheat, will be lifted, carried over and delivered into the catch trough **25a** while the clean wheat will be tailed over and discharged from the machine through the spout **35**. The small seeds and broken and small wheat and the like delivered into the catch trough **25a** will, by the feed screw **31a**, be delivered into the pocket **28** and by the paddle-acting elevator **33**, will be discharged into the third containing hopper **24b**. By the relatively small pockets of the discs **22b** the small seeds will be lifted, carried over and discharged into the catch trough **25b** and ultimately discharged through spout **36a** while the larger materials, such as very small kernels of whole wheat and larger portions of broken wheat, will be tailed over and discharged through spout **36**.

In the actions above described the stock in the first containing hopper **24** will be continuously fed or worked toward the right, in respect to Fig. 2, that is toward the spout **34**, by the propelling blades **23** of the discs **22** and at the same time, the stock in the containing hoppers **24a** and **24b** will be continuously fed or worked toward the left, in respect to Fig. 2, by the propelling blades of the discs **22a** and **22b**. By reference to Fig. 6 it will be noted that the grain or stock in the containing hoppers will be at an altitude above the bottoms of the large openings in the discs so that the progressive feed of the stock therethrough is made possible.

By combining the pocketed drums with the discs, it is made feasible and desirable to crowd the stock contained in the wheat as the major seed through the first separating compartment at a very high speed, thereby obtaining high capacity. This crowding of the commingled stock through the first separating compartment and past the first group of pocketed discs, very greatly increases the capacity of the machine. It makes possible the removal of all of the relatively long grain and seed such as oats, wild oats, and barley from the wheat and small seeds, but will result in carrying to the drums more or less wheat, which, however, may be readily and rapidly separated from the longer grains such as above noted.

In the use of the machine for separating commingled stock consisting chiefly of barley mixed with oats, wild oats, small amount of wheat and small seeds, such as buckwheat and cockle, the separating action will be as follows: The major part of the barley and all of the small seeds will be lifted by the first set of discs **22** and will be delivered to the second set of discs by separating actions already described, while all of the oats and larger barley, if any, will be tailed over and delivered to the separating drums,

By each drum the mixture received thereby will be discharged in two streams, to wit: the oats will be tailed over and delivered through spout **56** while the wheat separated from the oats by the drums will be discharged from the machine through the spouts **57**.

From the foregoing it is evident that the several groups of discs and the drum or drums perform their respective functions simultaneously and continuously throughout the operation of the complete machine. The several separating instrumentalities are assembled in a self-contained machine wherein the discs and the drum or drums are driven at the proper predetermined relative speeds necessary for efficient separating actions, for example, with the driving connections designed substantially as shown, the drums will be driven at the proper speed to take care of the commingled seeds or grains delivered thereto from the separating discs and the said discs will be driven at the proper relative speed to effect their several separations.

It will be understood that in the use of this machine it will be the common practice to remove from the commingled stock not only the straw and chaff and large foreign particles, but also the light dust and which operations may be accomplished by well known or any suitable scalping and aspirating devices.

From the foregoing it will also be understood that the commercial machine illustrated is capable of various modifications within the scope of the invention defined in the appended claims.

In this improved machine, I have co-operatively arranged two classes of separating devices, to wit: pocketed discs and pocketed drums or cylinders with co-operating devices and connections whereby the one class of separating elements first performs its function and then delivers the partly separated stock to the second class of separating devices, thereby relieving the latter from a large part of the work of separation. While the two classes of separations are performed in sequence, both classes of separating elements, to wit: the discs and the drums, operate continuously and simultaneously and the respective classes of separations are properly proportionate as between the disc and the drum or drums.

By combining the drum or drums with the several groups of discs having pockets of different size for different classes of separations, it is made feasible to perform the major separations by the discs and to cause the drum or drums to perform very efficiently the function for which they are best adapted, such as the separation of oats from barley.

The above described arrangement produces a machine of capacity far beyond that of either discs alone or drums alone. Moreover, the said elements are naturally and conveniently combined into a self-contained machine of very high capacity in respect to cost and space occupied.

What I claim is:

1. In a grain separator, a hopper-like container having an overflow conduit for tailings and having a catch trough at one side thereof, of a plurality of pocketed separating discs working in said container and adapted to pick up and deliver into said catch trough small seeds and relatively short grains such as wheat and to reject long grains such as oats and barley, an internally pocketed drum located adjacent said discs and container, the latter having an overflow spout for delivering directly into one end of said drum, the pockets of said drum being constructed and adapted to reject long grains such as oats, but to pick up and carry over shorter grains, means co-operating with said drum for maintaining separation of the grains picked up and the grains rejected by the pockets of said drum, and driving connections for

simultaneously rotating said discs and drum, whereby the said discs and drum simultaneously and continuously perform their different separating actions.

2. In a grain separator first and second hopper-like grain containers, first and second groups of pocketed discs working, respectively, in said grain containers, means for delivering commingled stock to the first container, the discs of the first group having pockets that are larger than the pockets of the second group, means whereby grain and seeds picked up by the discs of said first group will be delivered to said second container and subjected to the discs of the second group, an internally pocketed separating drum located below said discs and containers, said first noted container having an overflow conduit leading to one end of said separating drum, means for maintaining the separation effected by the discs of said second group, means for maintaining the separation effected by the pockets of said drum, and driving connections for simultaneously rotating said two groups of discs and said drum, whereby the several classes of separation will be simultaneously and continuously carried out.

3. The structure defined in claim 2 in further combination with a third hopper-like container, a third group of separating discs rotatable in unison with said first and second groups of discs and having pockets smaller than the pockets of the second group, and means for maintaining the separation effected by said third group of discs.

4. The structure defined in claim 2 in which there are two separating drums and co-operating elements, such as above defined, and in which the overflow from said first container is simultaneously delivered to both of said rotary drums, the said second drum being driven simultaneously with said first noted drum and said separating discs.

5. In a grain separator, first and second hopper-like containers, first and second groups of pocketed discs working respectively in said grain containers, the second set of discs having pockets that are smaller than the pockets of the first set of discs, a distributing hopper for the first container extending along one side of the first group of discs, said first container having an overflow conduit at one end and a catch trough at one side of the set of discs, a baffle extended below one end portion of said distributing hopper for causing the grain to bank up and maintain an approximate upper surface level in said container, means for delivering from said catch trough the grain picked up by the first group of discs and for delivering the same to the said second container, the latter having an overflow conduit for the tailings, and means for catching the grain elevated by the second group of discs and delivering the same from said second container.

6. In a self-contained machine for the separation of grain and like commingled stock, groups of pocketed separating discs and an internally pocketed separating drum, combined with stock-containing and separation maintaining devices, said groups of discs and drum having pockets differing in character or design and thereby adapted to receive and carry from commingled stock different shapes or sizes thereof, means feeding the commingled stock first to certain of said groups of pocketed discs, said certain groups of pocketed discs having pockets larger than the remaining groups and serving to classify said stock for delivery to said remaining groups of discs and to said separating drum, and means for simultaneously rotating said groups of discs and drum whereby the consecutive separating operations are simultaneously and continuously carried out.

7. In a machine of the class described, first and second sets of pocketed separating discs and a pocketed separating drum, constituting three separating devices, the pockets of said drum differing from those of said discs and the pockets of the two discs differing the one set from the other, and thereby adapted to receive and carry from the commingled stock different shapes and sizes thereof, means for feeding the commingled stock first to one of said three sets of separating devices and for maintaining the separation effected thereby, and means for delivering the stock separations effected by the first receiving set of separating devices, the one class thereof to said drum and the other to the other or second receiving set of discs, and means for maintaining the separations effected by said drum and second receiving set of discs, said feeding means being arranged to deliver stock into the interior of said drum so that the separations effected therein will be influenced by centrifugal force due to rotation of said drum.

8. In a machine of the class described, first and second sets of pocketed separating discs and an internally pocketed separating drum, the pockets of said drum and second set of discs differing from those of the first set of discs and thereby adapted to receive and carry from the commingled stock different shapes and sizes thereof, means for first feeding the commingled stock to said first set of discs and for maintaining the separations effected thereby, means for delivering the stock separations effected by said first disc, the one class thereof to said second set of discs, and the other class to said drum, and means for maintaining the separation effected by said drum and second set of discs, said feeding means being arranged to deliver stock into the interior of said drum so that the separations effected therein will be inflenced by centrifugal force due to rotation of said drum.

9. The structure defined in claim 6 in which the stock containing and separation maintaining devices include a catch trough within said drum and a trough-like container in which said discs work, said trough-like container having one edge over which the stock carried over by the discs will be delivered out of said containers.

10. The structure defined in claim 8 in which the means for maintaining the separations effected by said drum and discs includes a catch trough within said drum and a trough-like container in which said discs work, said trough-like container having one edge over which the stock carried over by the discs will be delivered out of said containers.

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