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PROCESS OF AND APPARATUS FOR MILLING FLOUR

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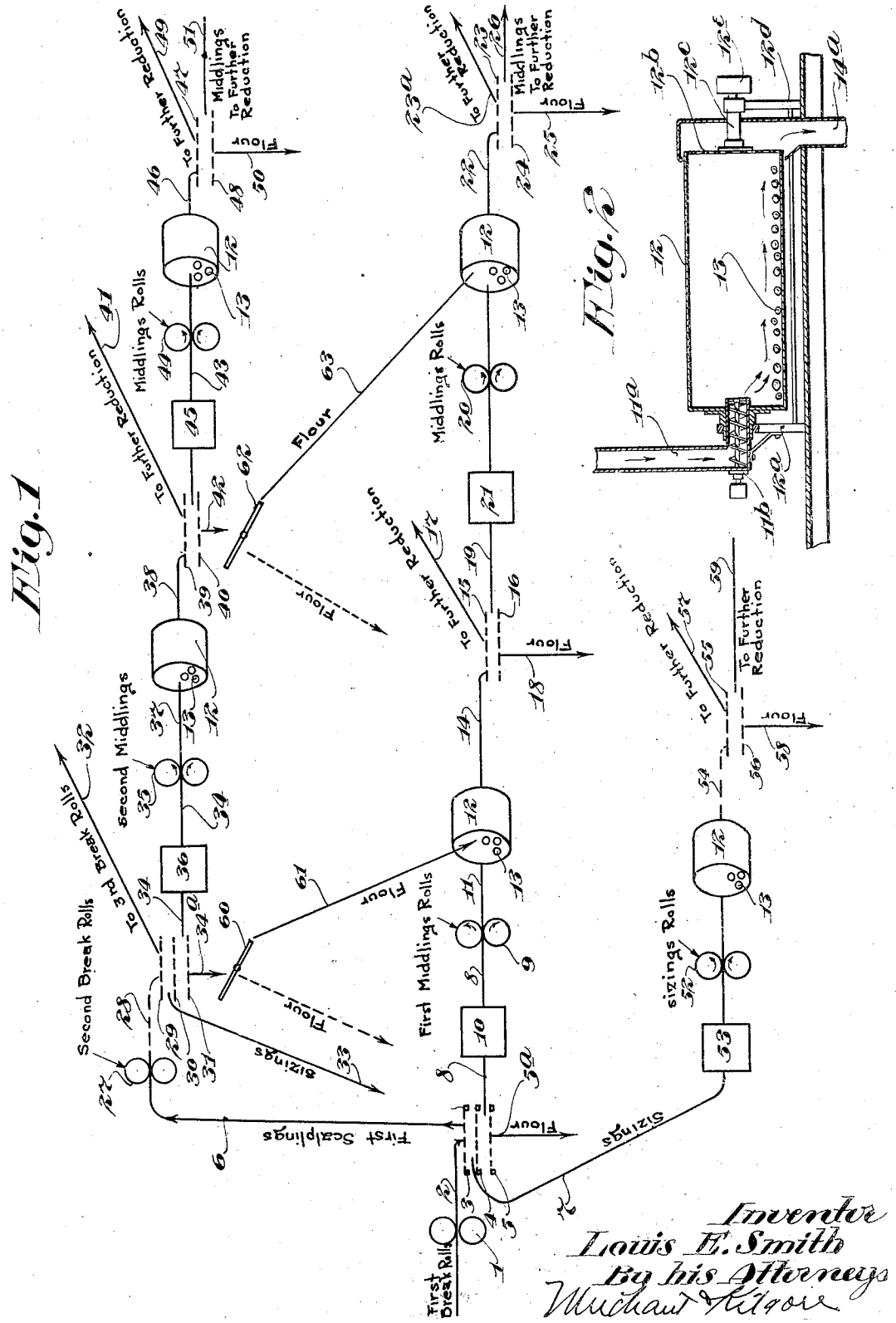

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UNITED STATES PATENT OFFICE

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PROCESS OF AND APPARATUS FOR MILLING FLOUR

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My invention provides an improved process and apparatus for the milling of flour and has for its object a simpler and more economical means than hitherto employed and whereby there is obtained a greater percentage of high-grade flour, a more complete and perfect separation of the bran from both high and low-grade flour, and improvements in the several grades of flour. Generally stated, the invention consists of the novel steps of manipulation and novel combinations of devices hereinafter described and defined in the claims. For the purposes of this case, the grain reduced to flour will be assumed to be wheat, although the process and apparatus may be used in the production of flour from other small grains and from corn. As is well known, the most difficult operation in the manufacture of flour is the complete separation of the fine bran particles from the endosperm or flour-producing substances of the whole wheat.

In the milling process now in general use, the whole wheat is first broken into what is known as "chops", by break rolls and thereafter the separation of the bran and the germ from the endosperm is accomplished by combined crushing and grinding actions alternated with sifting or separating actions. The combined grinding and crushing actions are generally produced by differentially driven rolls, that is, rolls, one of which is driven at a higher peripheral speed than the other so that there will be a grinding action produced simultaneously with the crushing action of the rolls.

The grinding action accompanying the crushing action has hitherto been considered as a necessity in order to break up the endosperm and separate the same from the bran, although it has been recognized that the grinding action produced by the differential movement of the rolls very greatly tends to break up the bran into small particles, some of which cannot thereafter be completely separated from the flour. Hence in timing the differential actions of the roll, it has been necessary to make a compromise between extreme differential action desirable for high capacity grinding and a minimum of differential desirable for crushing action. Another reason for the differential timing of the rolls has been found in the fact that crushing pressure of the rolls tends to form flour flakes which have been difficult to separate from the bran flakes and which have required further disintegration by grinding and sifting actions so that in practice the operation of the repeated combined pressure grinding and separating actions have necessarily been carried out to a very great length. Moreover, under the above old operation and process, the repeated grinding actions necessary to reduce the flour flakes results in reducing a considerable part of the bran to such fine condition that much thereof eventually finds its way into the various flour streams.

My invention results from the discovery or determination that a direct and simple crushing action such as produced from co-operating rolls driven at the same or nearly the same peripheral speed will crush or break down the endosperm with a minimum of grinding or breaking up of the bran or hull and incidentally will produce a large amount of flour flakes, but that these flour flakes may thereafter with a minimum and very slight breaking up of the bran or hull, be disintegrated and portions of the endosperm adhering to the bran particles may be separated from the bran and reduced to flour by subjecting the middlings or stock to a repetition of compressional impacts or reducing actions, such as produced by subjecting the stock to a free tumbling action in a container while commingled with loose impact-producing objects such as iron balls or particles.

A substantially horizontal rotary drum containing iron balls or the like is well adapted for the use just last indicated, to wit: a reduction of the flour flakes and separation of the endosperm from adhering bran flakes. The action of such a reducing device differs materially from that of the differentially driven rolls, millstones, and the like, for in such devices the co-operating grinding elements have definite fixed relation and move in definite paths so that any grain particle too large to pass freely between the same must necessarily be cracked and reduced and

the bran torn by the positive grinding actions of the grinding elements, whereas, in the tumbling mill used in this improved process, the balls or reducing elements have no definite paths of movement and no definite reducing actions, but float about producing impacts under yielding movements. Otherwise stated, the balls or reducing elements in the tumbling mill in acting, for instance, upon a large bran flake to which a considerable amount of endosperm is adhering, do not reduce the endosperm by a single impact, but by repeated impacts so that the flour flakes and endosperm are reduced and later separated from the bran progressively and without to any considerable extent breaking up the bran flakes. Also co-operating rollers tend to press together bran flakes and flour flakes and to cause them to adhesively couple up as bran flakes with adhering endosperm flakes, whereas the action of the balls of the tumbling mill have no tendency to cause the bran flakes to adhere to the flour flakes and on the contrary act to cause and maintain a separation of the bran flakes from the flour substance and, of course, as already described, reduces the flour flakes to flour. When the endosperm is crushed or broken down by pressure rolls or the like, a considerable part thereof is likely to be formed into flakes but these flakes or any other crushed portion of the endosperm have very much less cohesion than does the original or uncrushed endosperm, and hence such flakes or crushed endosperm may be readily reduced to flour by subjecting the same to a repetition of the shower of compressional impacts such as produced by the so-called tumbling mill containing reducing balls or elements.

Also it has been found that the wheat germ which, like the endosperm, will be, to a considerable extent, formed into flakes, will have greater cohesion in flake form than will the flour flakes and hence under proper regulation of the operation of the tumbling mill, the flour flakes will be reduced to flour without reducing the bran and germ flakes, thereby making separating of the germ as well as the bran from the flour a comparatively easy matter.

Tests have also shown that the gluten and starch granules of the flour are, to a considerable extent, broken down by the severe and repeated grinding actions hitherto employed in milling operations, but that the gluten and the starch granules are not broken down or damaged by the impact and rolling actions such as produced in accordance with my improved process in the use of the so-called tumbling mill. Breaking down of the gluten and starch granules in flour is known to be detrimental to the flour.

In utilizing the improved instrumentalities and operations above noted in a milling system, the crushing devices, separating devices and tumbling percussion devices are combined in a novel and proper manner for carrying out the improved process and may be combined with other devices such as purifiers, sifters and bolters, all as will hereinafter more fully appear.

The invention is illustrated in the accompanying drawings wherein like characters indicate like parts throughout the several views.

Referring to the drawings:

Fig. 1 is a diagrammatic flow sheet illustrating the process and various instrumentalities or devices used in carrying the same into effect; and

Fig. 2 is a vertical section taken axially through one of the so-called ball or tumbling mills diagrammatically shown in Fig. 1.

Referring to the diagrammatic view Fig. 1, the numeral 1 indicates a pair of first break rolls driven in the direction of the arrows marked thereon and mounted in the usual or any suitable way. By the rolls 1, the wheat is first broken into what is known as "chops". From the first break rolls, the "chops" as indicated by a flow line 2 will be conveyed to a bolter or sifting machine having a plurality of screens or sieves of which three are indicated by the numerals 3, 4 and 5, and the dimensions of which are progressively smaller from the upper to the lower member. In practice, of course, these screens or sieves will be vibrated as in ordinary flour mills. Bran with endosperm attached usually designated as first scalpings, will be scalped off from the upper sieve or screen 3 as indicated by a flow line 6. Particles of endosperm and germ of about the same size mixed with some fine bran particles and which mixture is usually designated as sizings, is scalped off from the second screen 4, as indicated by flow line 7. Rather fine particles of pure endosperm with attached or commingled fine bran particles which pass through the meshes of the screen 4 are scalped off from the lower screen 5, as indicated by flow line 8, and flour will pass through screen 5 as indicated by flow line 5^a. In the bolter that involves the screens 3, 4 and 5, some further or minor separations may be performed but for the purpose of this case, such may be here ignored.

The middlings travel as indicated by flow line 8 and are delivered to co-operating crushing rolls 9, herein designated as first middlings rolls. These rolls will be driven, in the direction of the arrows marked thereon, in the usual or any suitable way but at the same or nearly the same peripheral speed or at any rate, at such slight speed differential as will not disintegrate the bran to any appreciable extent. In the flow line 8, an ordinary purifier 10 such as generally used in flour mills may be arranged for the passage of the middlings therethrough and the separation therefrom of light bran particles.

The rolls 9 further crush the endosperm and form flour flakes, but do not disintegrate the bran particles.

From the middlings rolls 9, the middlings will be conveyed as indicated by flow line 11 to a means for subjecting the same to a shower of compressional impacts, the said means as illustrated being an approximately horizontal rotary drum 12 containing iron or metal balls 13 or the like arranged to freely roll about within said drum under rotation of the latter. The middlings passed through the drum 12 will be rolled about while commingled with the balls 13 and the middlings and the balls will be continuously raised and caused to roll or fall back in a continuous shower so that the middlings will, as already indicated, be subjected to a mild but continuous reducing action, herein designated as a shower of compressional impacts. This so-called shower of compressional impacts of continuous and repeated mild reducing actions, loosens the endosperm from the bran particles and reduces the endosperm to flour without, to any considerable extent, breaking up or disintegrating the bran particles. The flour flakes produced by the rolls 9 will, of course, by this action be broken up and reduced to flour form and as there is no intense compression produced between the flour or flour flakes and bran flakes, no cohesion between the flour and the bran flakes is produced. In some instances, a sieve or separating means may be interposed in the flow line 11 between the rolls 9 and drum 12 for taking off some flour. The rotary drum 12 with its reducing balls or elements 13 are sometimes designated as tumbling mills and sometimes as ball mills and which have heretofore been extensively used for reducing cement, but should be of the type to permit the continuous flow of middlings therethrough. Said mill may, for example, be of the type illustrated in Fig. 2, which is a vertical axial section through the mill and will be hereinafter described more in detail.

From the drum 12 of the first ball mill, the middlings are delivered as indicated by flow line 14 to a bolter or sifter having one or more sieves or screens, the same in the present instance being illustrated as having two sieves 15 and 16. As indicated by flow line 17, scalpings for further reduction are scalped off from the upper screen 15, flour is sifted through the lower screen 16, as indicated by flow line 18, and the middlings, as indicated by flow line 19 are delivered to crushing rolls 20 of the same general character as the rolls 9. A purifier 21 may be interposed in the flow line 19. By the rolls 20, the unreduced portions of the endosperm are further crushed and reduced without to any considerable extent breaking up the bran flakes and from said rolls, the stock is delivered to a second tumbling mill or ball mill of the same character as the first noted mill 12—13 and of the same character as the said mill illustrated more in detail in Fig. 2. By the action of this tumbling mill, the endosperm is further loosened from the bran flakes and reduced to flour form and flour flakes produced by the roll 20 will also be disintegrated and reduced to flour form. As indicated by flow line 22, the further reduced middlings will be delivered to a third separator such as a bolter, which, as shown, has two sieves 23 and 24. Scalpings for further reduction will be scalped off from the upper screen 23, see flow line 23a; flour will be sifted through the lower sieve 24, as indicated by flow line 25; and the unreduced middlings, if any, with attached or commingled fine bran particles will be scalped off from the sieve 24, as indicated by the flow line 26 and the actions above described may be repeated until the reduction of the endosperm to flour has been completed.

The first scalpings, as indicated by flow line 6, are delivered to second break rolls 27. These second break rolls in their structure and operation are much like the first break rolls 1, but preferably have corrugations that are finer than those provided on the first break rolls. The first scalpings consist largely of broken wheat particles and bran with endosperm attached and by the action of the second break rolls 27, the endosperm will be crushed and loosened. From the second break rolls 27, as indicated by flow line 28, the stock is delivered to a bolter which as illustrated, has three sieves or screens 29, 30, and 31. As indicated by flow line 32, scalpings are scalped off from the upper screen 29 and may be delivered for further reduction to third break rolls for continued reduction.

The sizings passed through upper screen 29 will be scalped off from the screen 30, as indicated by flow line 33, the flour will be sifted through the lower screen 31, as indicated by flow line 34a, and the middlings will be scalped off from the lower screen 31, as indicated by flow line 34. The middlings will be delivered between second middling rolls 35, which, in their construction and operation, are like or substantially like the rolls 9. A purifier 36 may be interposed in flow line 34. From the second middlings rolls 35, the stock goes, as indicated by flow line 37, to a ball or tumbling mill of the character already described and which consists of a rotary drum 12 containing reducing balls 13. By the action of this mill and with an action already more fully described, the endosperm is reduced to or toward flour form without breaking up the bran and the flour flakes formed by rollers 35 will be disintegrated and reduced to flour. From drum 12, the stock goes as indicated by flow line 38 to a bolter which, as shown, has sieves 39 and 40.

Scalpings for further reduction are scalped

off from upper sieve 39 as indicated by flow line 41; flour is sifted through lower sieve 40, as indicated by flow line 42; and the middlings as indicated by flow line 43 is delivered to middlings rolls 44 which are constructed and operate like the rollers 20. If desired, a purifier 45 may be interposed in flow line 43. From rolls 44 the middlings go to another ball or tumbling mill 12—13 by which and under an action already described, the endosperm is further reduced and the flour flakes produced by the pressure of rolls 44 are reduced to flour without breaking up the bran flakes. From this last drum 12, the middlings go, as indicated by flow line 46, to another bolter which, as shown, has sieves 47 and 48. Scalpings for further reduction are scalped off from the upper screen 47, as indicated by flow line 49; flour goes through lower sieve 48, as indicated by flow line 50; and the middlings for further reduction are scalped off from sieve 48, as indicated by flow line 51. In some instances, it may be desirable to interpose sifting or separating devices for drawing off flour at one or more points such, for example, as between rolls 9 and drum 12 and rolls 44 and drum 12, rolls 20 and drum 12 and rolls 52 and drum 12, and between rolls 35 and drum 12.

The sizings as indicated by flow line 7, go to compression rolls herein designated as sizings rolls 52 and are constructed and operate substantially the same as rolls 9 and 35. If desired, a purifier 53 can be interposed in flow line 7. By rolls 52 the endosperm will be crushed and separated or loosened from the bran particles and flour flakes will be produced by the compressing action of the rolls but the bran particles will not be disintegrated or broken up to any considerable extent. Also the germ particles will be formed into flakes.

In the specification, the term "bolter" is used in a broad sense to include any and all kinds of suitable flour-sifting devices.

This stock consisting of some flour, flour flakes, germ flakes and bran flakes go to a ball or tumbling mill which, like the tumbling mills previously described, comprises a rotary drum 12 containing reducing balls 13. By the action of this mill, the endosperm and flour flakes will be reduced to flour form without reducing or disintegrating the germ flakes and without breaking up the bran flakes. The stock then goes to a bolter as indicated by the flow line 54 which, as shown, comprises sieves 55 and 56. The bran particles and the germ flakes will be scalped off from its upper screen 55 as indicated by flow line 57; the flour will pass through lower sieve 56, as indicated by flow line 58 and the middlings, as indicated by flow line 59, will be scalped off from screen 56 for further reduction.

I have found that in practice the above described action of the ball or tumbling mill, in addition to the functions already discussed in detail, improves the quality of the flour and hence, in some instances, it may be desirable to pass the flour as frequently as possible through these impact-producing devices or mills. This could be accomplished in many ways but the following will illustrate: The flour from flow line 34 by a deflector or guiding means 60 could be directed as by a flow line 61 into the first mill 12—13; and the flour from flow line 42 by a deflector or guiding means 62 might be directed by a flow line 63 into the second ball or tumbling mill.

The ball mill shown in Fig. 2 is typical of all of the ball or tumbling mills illustrated in the diagrammatic flow sheet but may be assumed to be the first described ball mill for the reason that as lettered the supply spout 11^a indicates the flow line 11 and the discharge spout 14^a indicates the flow line 14. At its receiving end, the drum 12 has a large hollow trunnion journaled in the supporting bearing 12^a and at its other end, said drum is journaled in the expanded upper end of the discharge spout 14^a and is provided with a perforated head 12^b through which the stock can freely pass but which will not permit the discharge of the balls 13. The supply spout 11^a has a sleeve extended through the large trunnion of the drum 12 and working therein is a spiral conveyor 11^b. This arrangement, of course, permits a continuous flow of stock through the drum. The head 12^b of said drum is provided with a trunnion 12^c journaled in a bearing 12^d and said trunnion is shown as provided with a pulley 12^e by means of which the drum may be rotated.

This system is adapted to be used in a flour mill on so-called sizings, middlings or tailings stock. This stock is produced from so-called "chops" or parts thereof after grinding. Various streams of middlings and sizings are then subjected to sifting or sifting and aspiration, then delivered to the so-called sizings or middlings rolls and after this process and the possible removal of some flour, the stock is then to be delivered to tumbling drums, after which it is subjected to further sifting or sifting and aspiration, where some flour is taken out and the remainder carried again to further reduction along the lines mentioned above.

What I claim is:

1. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, some of which endosperm is pressed into the form of flakes, in repeatedly subjecting the middlings portion of the resulting stock to a multiplicity of non-uniform compressional impacts whereby the endosperm and flakes thereof are further reduced to or toward flour form without

materially disintegrating the bran flakes, and in separating the bran from the flour.

2. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, in separating a portion of the bran and a portion of the flour to isolate the middlings, in repeatedly subjecting the middlings to a multiplicity of uncontrolled compressional impacts whereby the endosperm and flakes thereof are further reduced to or toward flour form without materially disintegrating the bran flakes, and in separating the bran from the flour.

3. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, in separating a portion of the bran and a portion of the flour to isolate the middlings, in subjecting the middlings to a further crushing compression thereafter repeatedly subjecting the middlings to multi-directional and uncontrolled impacts, whereby the endosperm and flakes thereof are further reduced to or toward flour form without materially disintegrating the bran flakes, and in separating the flour from the bran and other particles not reduced to flour.

4. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, in separating a portion of the bran and a portion of the flour to isolate the middlings, in subjecting the middlings to a further crushing compression, thereafter repeatedly subjecting the middlings to a multiplicity of uncontrolled compressional impacts whereby the endosperm and flakes thereof are further reduced to or toward flour form without materially disintegrating the bran flakes, in separating the flour from the bran and other particles not reduced to flour, in again subjecting the middlings to a crushing compression action, and in again repeatedly subjecting the flour-producing stock to a multiplicity of uncontrolled compressional impacts and thereafter separating the flour from the bran particles and other particles not reduced to flour.

5. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, in separating the stock into at least three streams, to wit: middlings, scalpings and sizings, in subjecting the middlings to a further crushing compression, then to a multiplicity of uncontrolled compressional impacts and then to a flour sifting action; in subjecting the scalpings to a further crushing compression, then to a flour separating action, then to a further crushing compression, then to a multiplicity of uncontrolled compressional impacts and then to a flour separating action; and in subjecting the sizings to a further crushing compression, then to a multiplicity of uncontrolled compressional impacts and then to a flour separating action.

6. The process defined in claim 5 in which, in addition to the steps therein noted, the middlings are subjected to a further crushing compression, then to a further multiplicity of uncontrolled compressional impacts and then to further flour separating action.

7. The process defined in claim 5 in which both the middlings and the flour-producing stock from the scalpings are subjected to further crushing compressions, then to a further multiplicity of uncontrolled compressional impacts, and then to further flour separating actions.

8. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack and loosen the bran or hull, in subjecting the cracked grain to a separating action whereby a portion of the bran is removed to isolate the middlings, in subjecting the middlings to a crushing compression to further reduce the same to flour, some of which will be pressed into the form of flour flakes, in subjecting stock thus treated to a multiplicity of uncontrolled compressional impacts to disintegrate the flour flakes and further reduce the flour middlings, and in subjecting the stock thus treated to a second separating action to separate the loose flour from the minor bran flakes and remaining coarse portions.

9. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack and loosen the bran or hull, in subjecting the cracked grain to a separating action whereby a portion of the bran is removed to isolate the middlings, in subjecting the middlings to a further crushing compression to further reduce the same to flour, some of which will be pressed into the form of flour flakes, in tumbling and at the same time subjecting the stock thus treated to a shower of compressional impacts to disintegrate the flour flakes and further reduce the flour middlings, in subjecting the stock thus treated to a second separating action to separate the loose flour from the minor bran flakes and remaining flour flakes, in subjecting the undisintegrated flour particles and minor bran flakes to a third crushing compression to thereby further reduce the flour-forming particles, in tumbling and at the same time subjecting stock thus treated to the action of a second shower of compressional impacts to further disintegrate the flour flakes and endosperm, and in subjecting stock thus treated to a third separating action whereby the flour is separated from the minor bran particles and other particles not reduced to flour.

10. A flour milling system comprising

means for subjecting whole wheat to a crushing compression to crack the bran and break down the endosperm and to press some of the endosperm into flake form, means for subjecting a portion of the resulting stock to a multiplicity of non-uniform compressional impacts whereby the endosperm and flakes thereof are further reduced to or toward flour form without materially disintegrating the bran flakes, and means for separating the flour from the bran, combined with means for delivering the stock from the one to the other of said means.

11. A flour milling system comprising rollers operative with a crushing compression to crack the bran and break down the endosperm and to press some of the endosperm into flake form, a tumbling mill including a rotary drum and loose reducing elements therein, arranged to receive a portion of the resulting stock and to subject the same to a shower of multi-directional movable members whereby the endosperm and flakes thereof are further reduced to or toward flour form without materially disintegrating the bran flakes, and separating means for separating the flour from the bran and other particles not reduced to the form of flour, combined with means for delivering the stock from the one to the other of said means.

12. A flour milling system comprising crushing rolls operative on the whole grain with a crushing compression to crack and break down the endosperm, separating sieves for separating the middlings from the scalpings and sizings, other crushing rolls operative on the middlings to further crush and compress the same, and means thereafter operative on the middlings to commingle the same with freely movable impacting bodies whereby the endosperm and flakes thereof are further reduced to or toward flour form without materially disintegrating the bran flakes, and additional separating means for subsequently separating the flour from the bran and other particles not reduced to the form of flour, combined with means for delivering the stock from the one to the other of said means.

13. The structure defined in claim 12 in further combination with additional crushing and compressing rolls further operative on the flour-producing stock, additional means for next subjecting the flour-producing stock to a shower of uncontrolled loose members whereby the endosperm and flakes thereof are further reduced to or toward flour form without materially disintegrating the bran flakes, and further separating means subsequently operative on the flour-producing stock to separate the flour from the bran and other particles not reduced to flour.

14. A flour milling system comprising means for subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, separating means operative to separate the stock thus compressed and cracked into three streams, to wit: middlings, scalpings and sizings, means for subjecting the middlings to a further crushing compression, then to multi-directional moving compressional members and then to a flour sifting action; means for subjecting the scalpings to a further crushing compression, then to a flour sifting action, then to a further crushing compression, then to multi-directional moving compressional members, and then to a flour-separating action; and means for subjecting the sizings to a further crushing compression, then to multi-directional moving compressional members and then to a flour-separating action.

15. The structure defined in claim 14 in further combination with means for subjecting the middlings to a further crushing compression, then to multi-directional moving compressional members and then to further flour-separating action.

16. A flour milling system comprising means for subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, separating means operative to separate the stock thus compressed and cracked into three streams, to wit: middlings, scalpings and sizings, means for subjecting the middlings to a further crushing compression, then to a shower of non-uniform compressional impacts and then to a flour sifting action; means for subjecting the scalpings to a further crushing compression then to a flour sifting action, then to a further crushing compression, then to a shower of non-uniform compressional impacts, and then to a flour-separating action; and means for subjecting the sizings to a further crushing compression, then to a shower of non-uniform compressional impacts and then to a flour-separating action.

17. The structure defined in claim 16 in further combination with means for subjecting the middlings and the flour-producing stock from the scalpings to further crushing compressions, then to further showers of non-uniform compressional impacts and then to further flour-separating actions.

18. The process of milling flour which consists in subjecting the whole grain to a crushing compression to crack the bran and break down the endosperm, some of which endosperm is pressed into the form of flakes, and commingling a portion of the resulting stock with freely movable impacting bodies, tumbling the aggregation to further reduce the endosperm and flakes to or toward flour form without materially disintegrating the bran, and in separating the bran from the flour.

19. The process of milling flour which consists in subjecting the whole grain to a crush-

ing compression to crack the bran and break down the endosperm, some of which endosperm is pressed into the form of flakes, and simultaneously commingling a portion of the resulting stock with freely movable impacting bodies and cascading the aggregation to further reduce the endosperm and flakes to or toward flour form without materially disintegrating the bran, and in separating the bran from the flour.

In testimony whereof I affix my signature.

LOUIS E. SMITH.