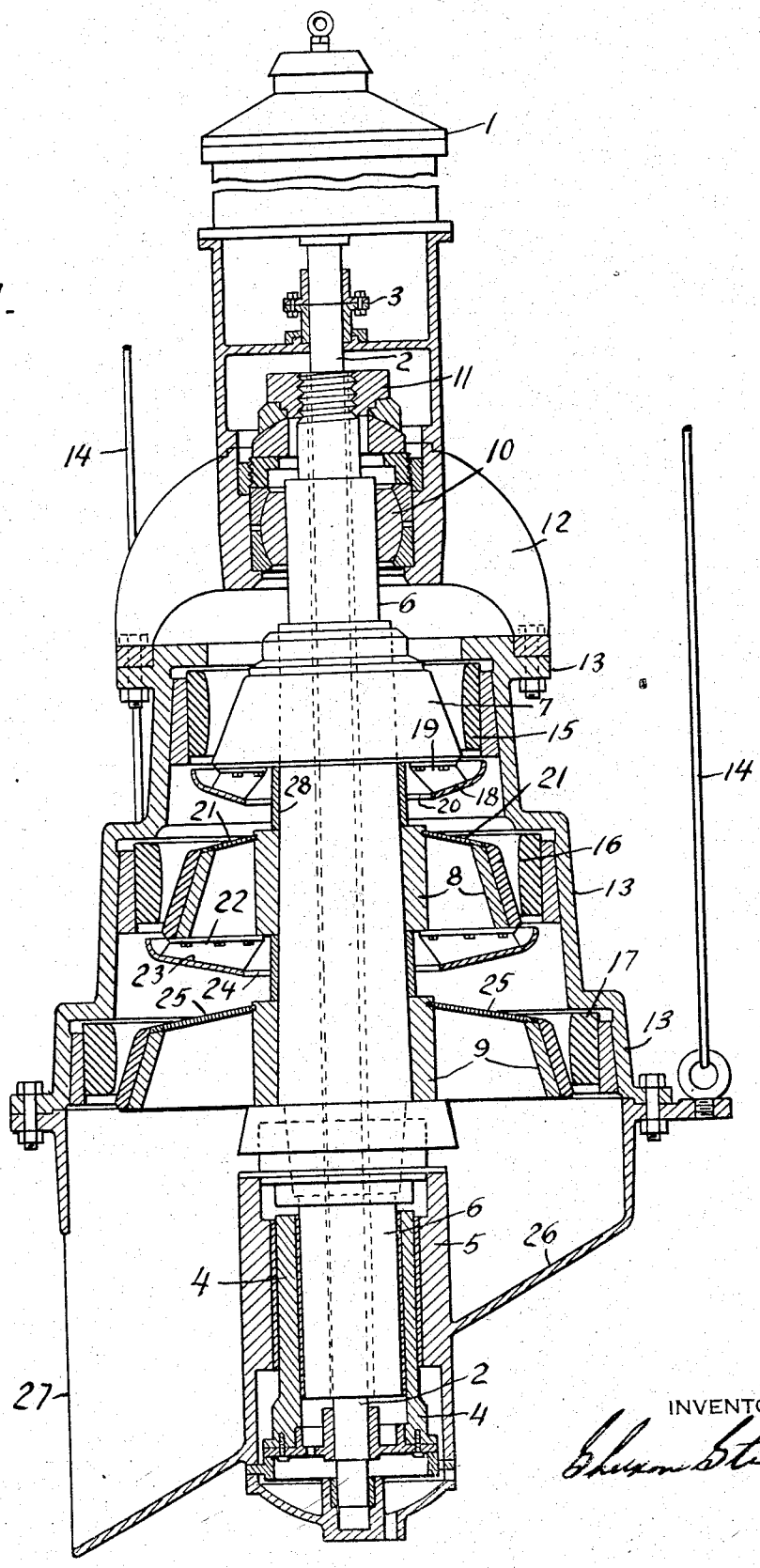
Nov. 28, 1939. S. STEARNS 2,181,571

CRUSHING MACHINERY

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Fig. 1.



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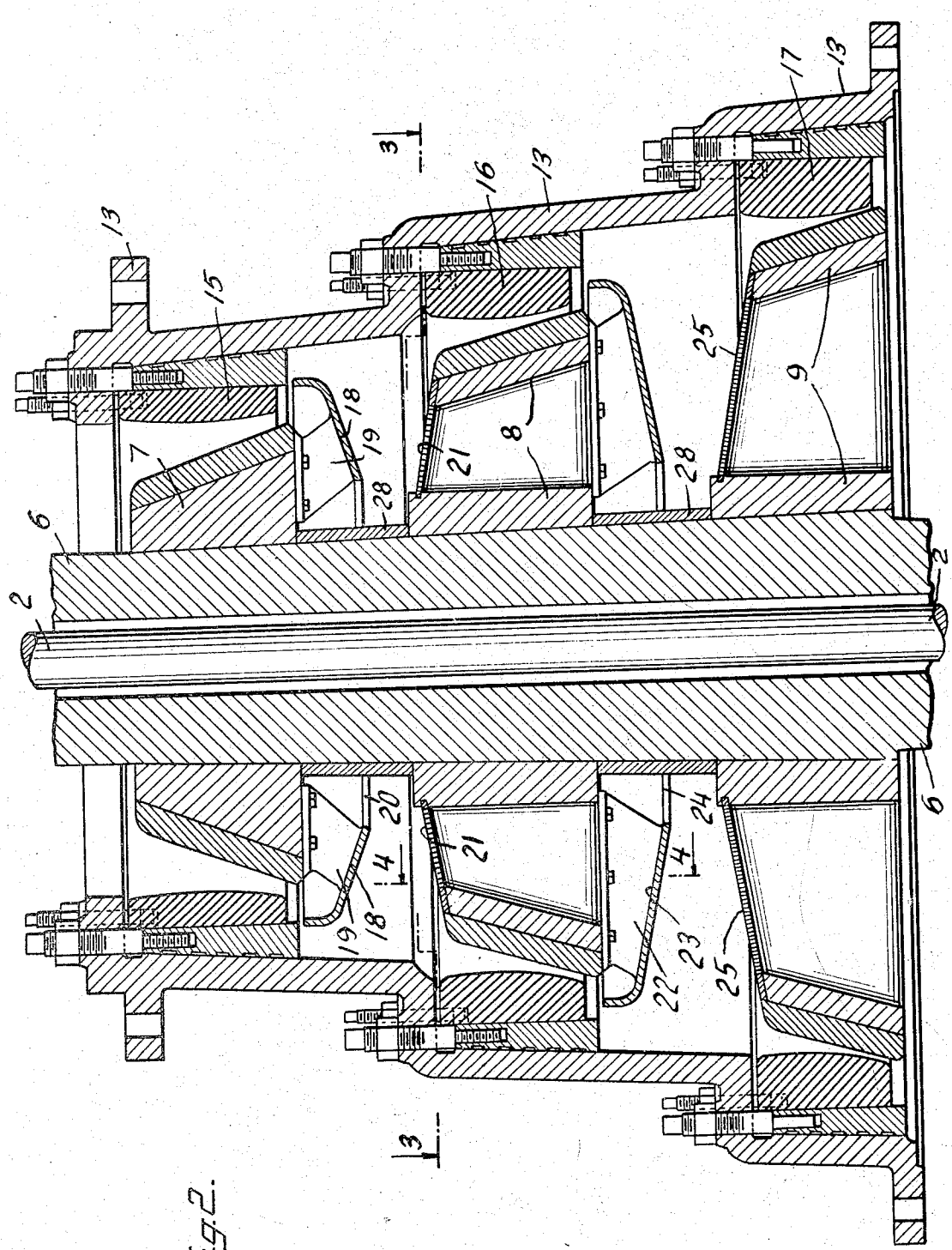


Fig. 2.

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CRUSHING MACHINERY

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Fig. 3.

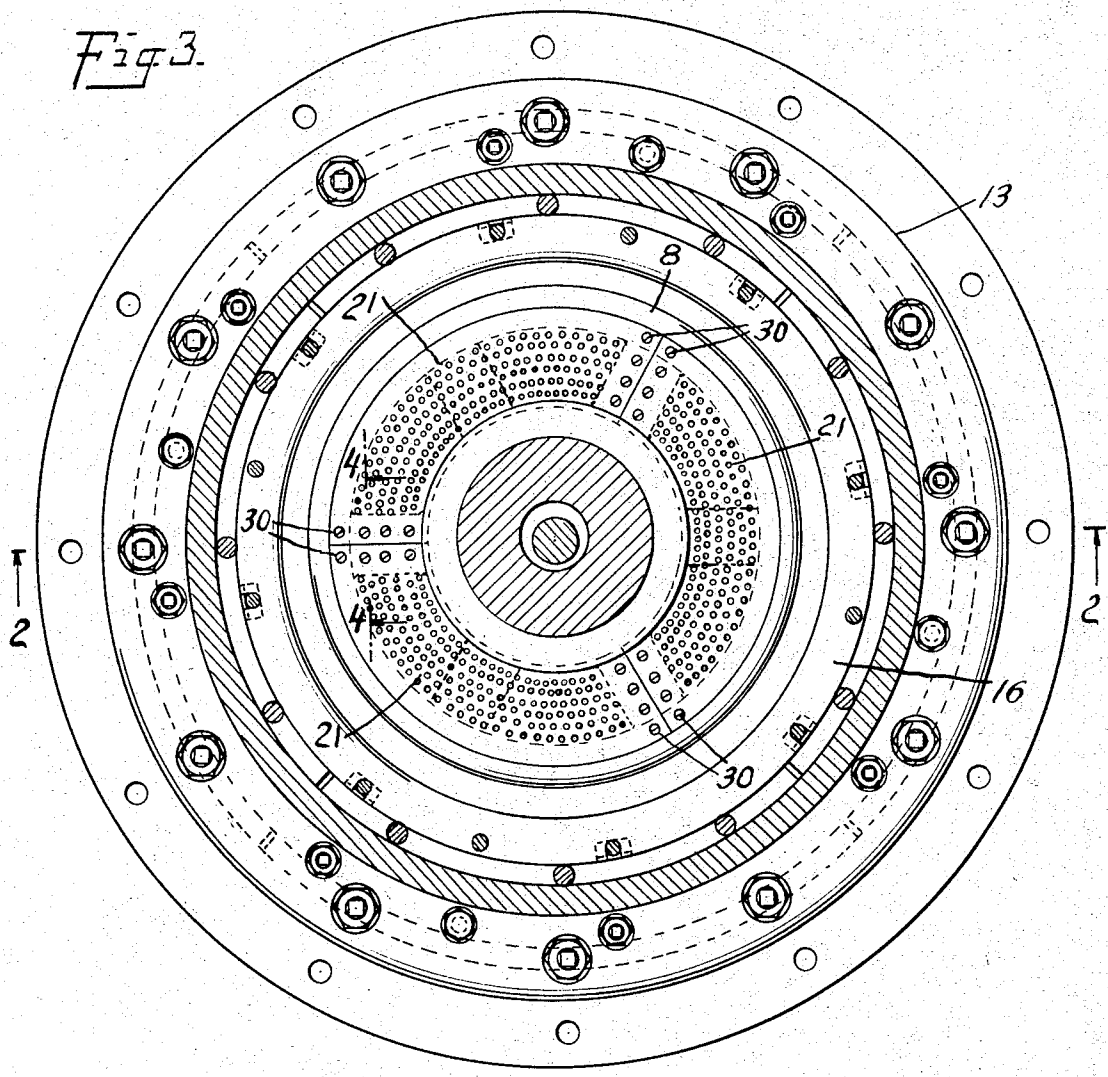
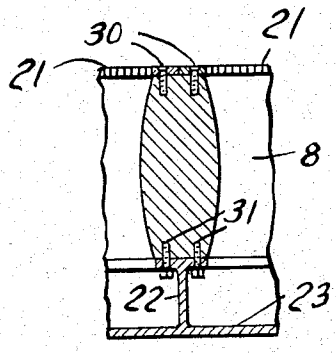


Fig. 4.



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Nov. 28, 1939. S. STEARNS 2,181,571

CRUSHING MACHINERY

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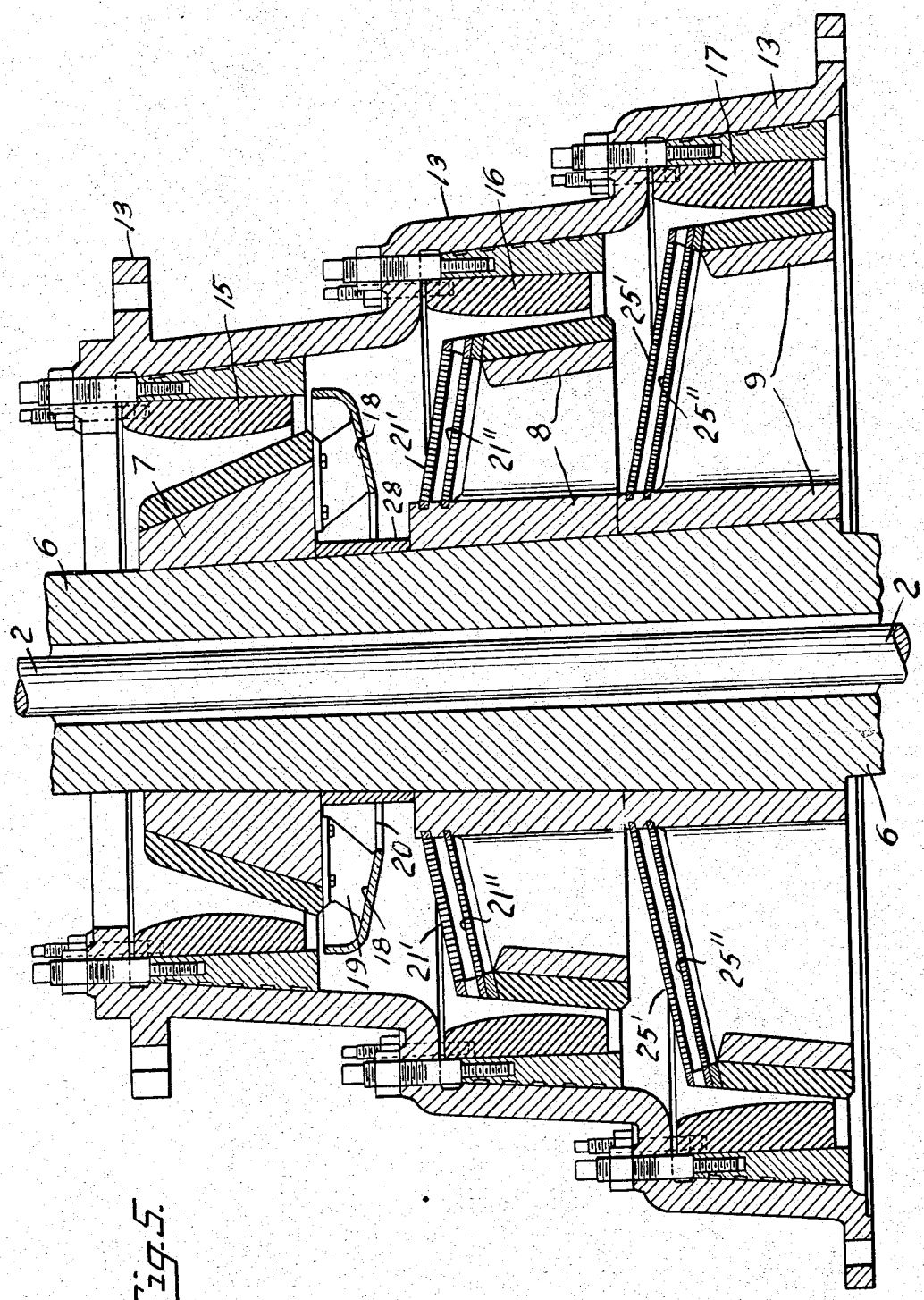


Fig. 5.

INVENTOR

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CRUSHING MACHINERY

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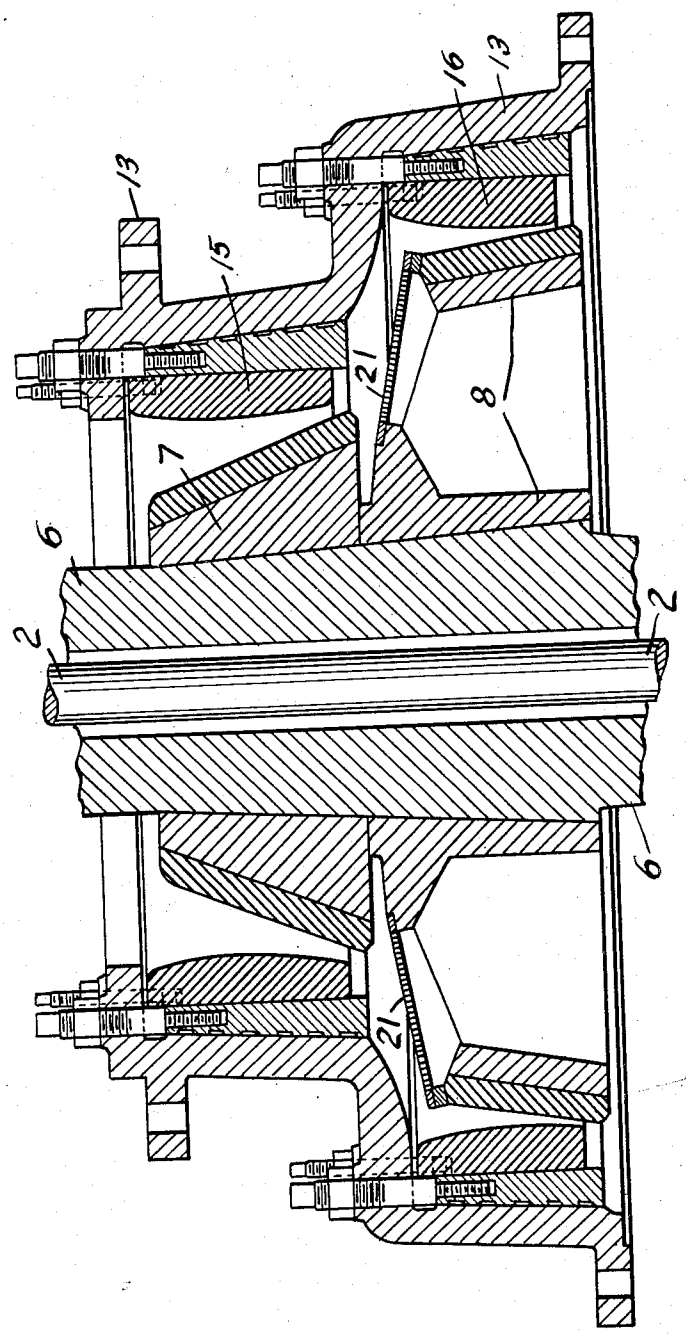


Fig. 6.

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CRUSHING MACHINERY

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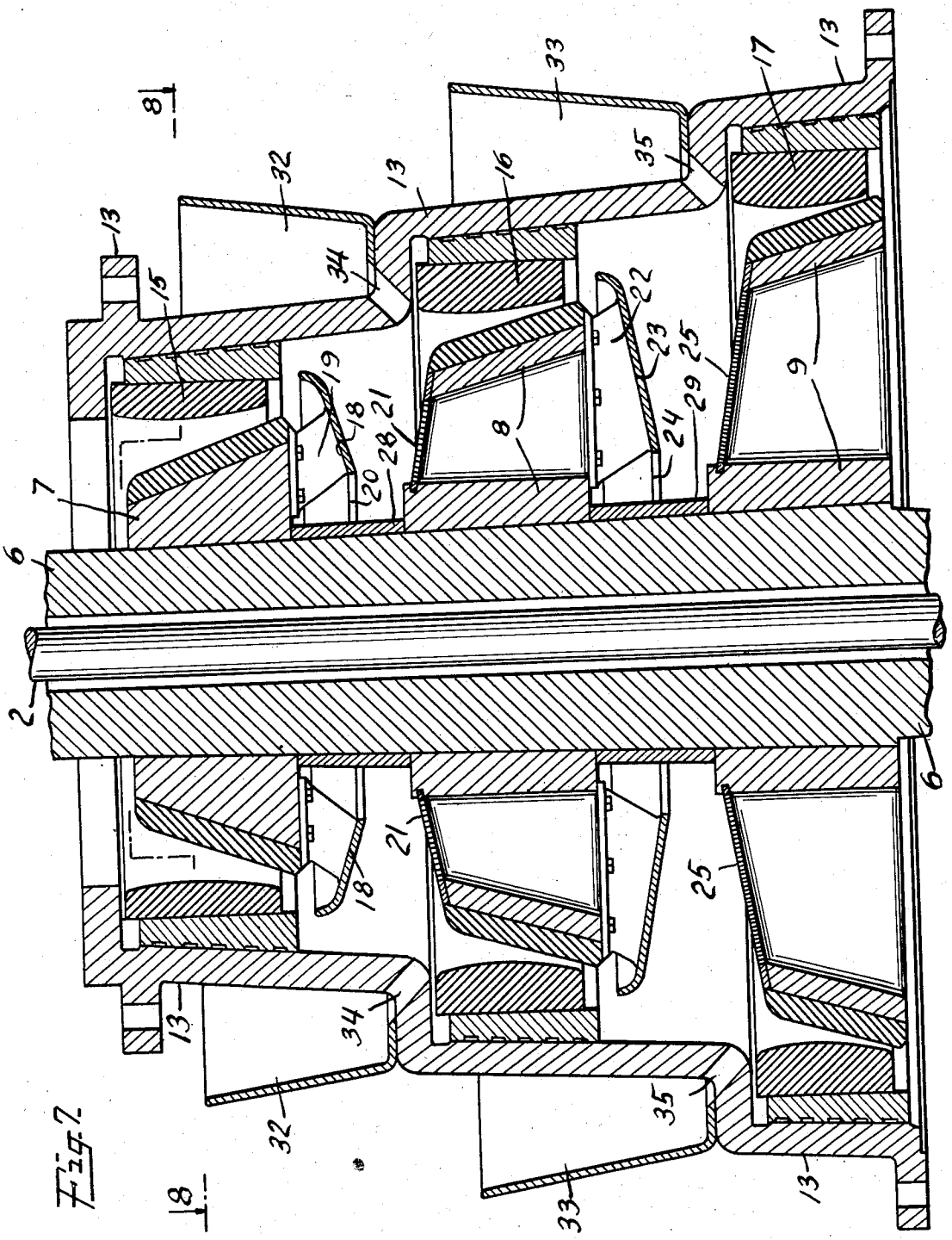


Fig. 7.

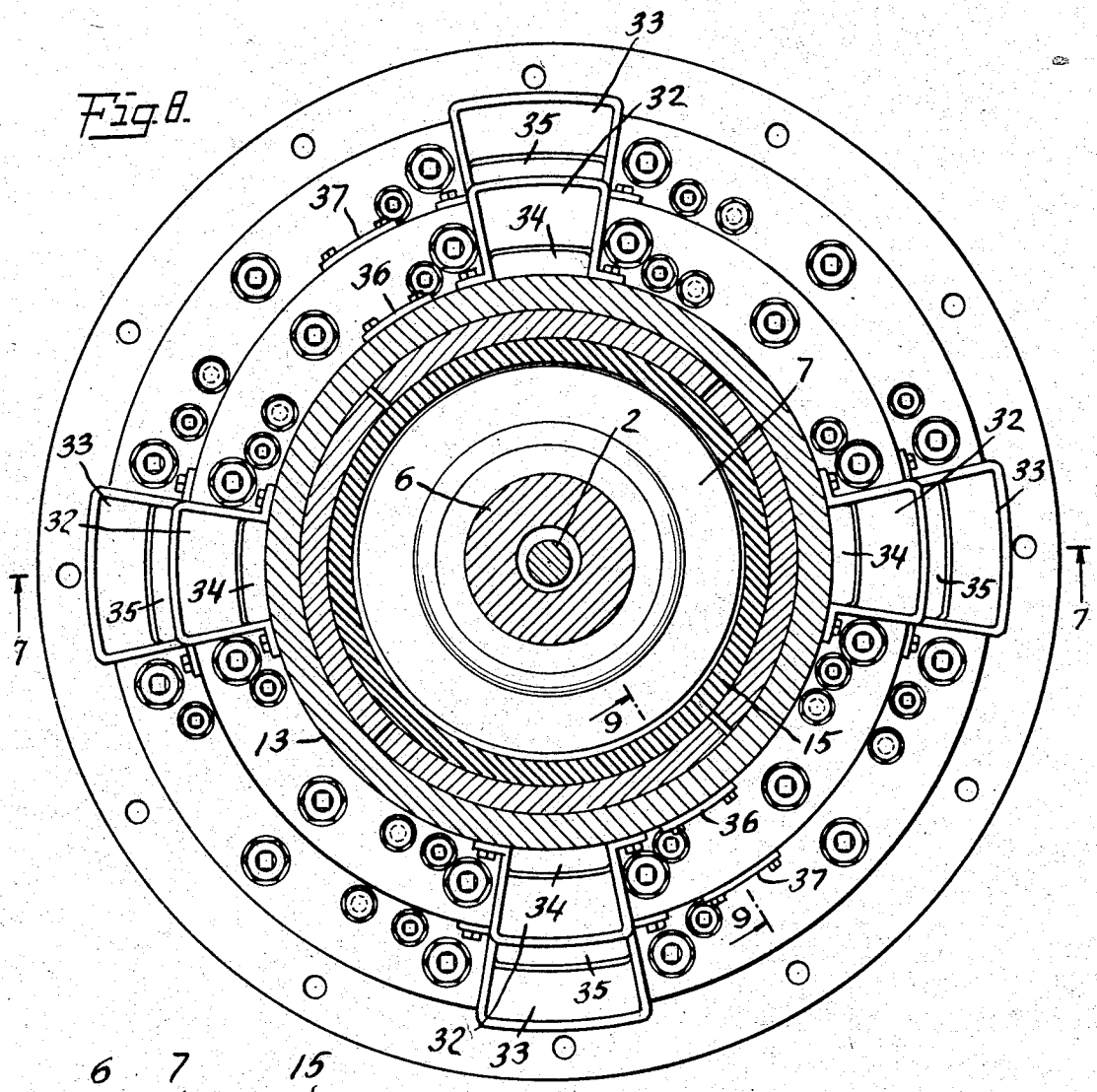
INVENTOR

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CRUSHING MACHINERY

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Fig. 8.



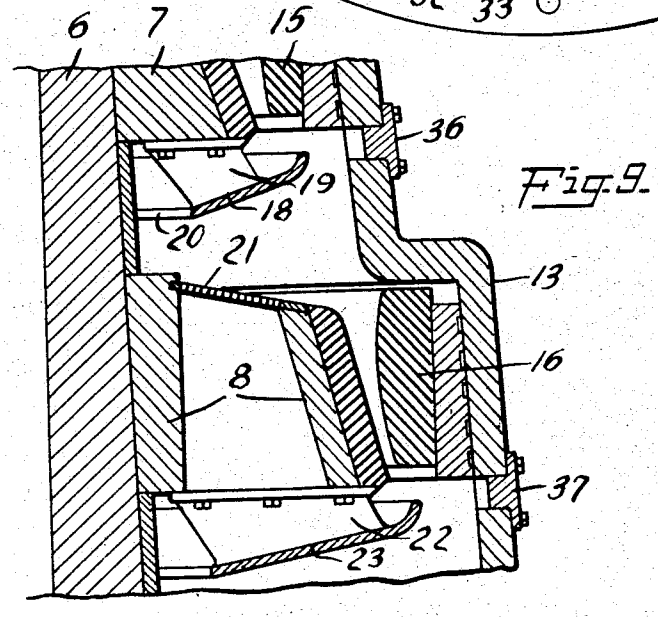


Fig. 9.

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Patented Nov. 28, 1939 2,181,571

UNITED STATES PATENT OFFICE

2,181,571

CRUSHING MACHINERY

Sheldon Stearns, Westfield, N. J.

Application November 10, 1936, Serial No. 110,035

9 Claims. (Cl. 83—10)

My invention relates to improvements in crushing machinery, in particular to the type of crushing machinery known as gyratory crushers in which material is crushed in two or more stages as fully described in my patent application, Serial #38,016, filed August 27, 1935, which issued as Patent 2,147,721 on February 21, 1939.

In such a multi-stage gyratory crusher there are two or more centrally located conical crushing heads mounted upon a vertical shaft. One end of this vertical shaft is gyrated by means of an eccentric driven directly or indirectly by a motor. The other end of the shaft is centrally and pivotally mounted. Surrounding these conically shaped heads are stationary concaves or crushing surfaces so shaped as to form a large entrance opening between each conical head and its concave at the top, and a continuously narrowing space between each head and its concave towards the lower or discharge end. The shaft with its heads does not revolve, but is so gyrated that the heads move towards and away from their concaves at every point of their circumference, once for every revolution of the eccentric. The minimum clearance between each of the heads and their corresponding concaves for any stage is at their discharge ends. Material to be crushed is introduced at the top or entrance opening between the head and its concave of the first crushing stage, and is gradually crushed to size as it passes through the succeeding crushing stages due to the gyrating motion of the heads, until it is finally discharged from the last stage of the crusher. In other words, the first crushing stage serves to crush the material from its original size to some definite intermediate size, and is discharged from the first crushing stage and allowed to enter the second crushing stage. Two or more stages are used for crushing the material from its original size to the desired final size. The clearance between the concave and the crushing head of the first stage at their discharge ends is so designed that it does not pass more material at that point than can be accommodated or crushed during an equal interval of time in the second crushing stage. If the crushing of the material is accomplished in more than two stages, the clearance between the concave and the crushing heads at their discharge ends of each crushing stage is so proportioned that it does not pass more material than can be crushed in an equal interval of time in the succeeding stage. Material in passing from stage to stage is gradually crushed to a finer size until it reaches the desired degree of fineness when discharged from the last stage.

During such a crushing operation the crushed material discharged from the first stage is of various sizes. A small percentage of the material might be somewhat larger in size than the minimum discharge clearance of the first stage; a large percentage of the crushed material is approximately of the size of the minimum clearance of the first stage and some of the material has been crushed to still smaller dimensions and some of it might even be to a fineness smaller than the desired fineness from the last crushing stage. The actual percentages of various sizes of the material as it is discharged from the first stage depends upon the friability of the material crushed.

I have found that if this undersize material continues to pass through succeeding crushing stages a portion of it is crushed still finer in each successive stage, and thus will produce a final crushed material which may contain too great a percentage of material reduced in size below the final degree of fineness.

To overcome this disadvantage, I have placed between crushing stages screens or grids for separating these fines from the coarse material. These screens or grids are mounted on the top of the gyrating heads so that they are a part of the gyrating system. The screens permit the fines to pass through them and carry the coarse material remaining on the screens into the receiving opening of the succeeding stage. The fines, after passing through the screens, drop through appropriate openings in the head directly below the screens. In this manner the fines are made to by-pass the next succeeding crushing stage or stages. In most all gyratory crushers vibrations exist during the crushing operation. These vibrations are transmitted to the screens and give them a vibratory motion similar to the vibrating screens commonly used for screening crushed material.

Hence, by gyrating and vibrating the screens I not only secure efficient screening but it also permits positioning the screens at a small angle to the horizontal and still have them capable of delivering the oversize material remaining on the screens to the receiving opening of the succeeding stage.

In order to secure as great a screen area as possible, I also provide a chute or conveying surface on which the discharged material from a preceding stage may drop and which conveys the material to the screen below it as close to the gyrating shaft as possible. This conveying surface is fastened to the bottom of the head of that crushing stage from which the material is being discharged so as to give this conveying surface a gyratory and vibratory motion which assists so greatly in moving the material over the conveying surfaces.

It should be noted however that where the difference of diameters between the discharge of any stage and the intake of the succeeding

stage is sufficient to provide ample screen area the above mentioned chute or conveying surface can be omitted and the material discharging from any stage may drop directly upon the screen.

It is not necessary to have the screen area so great as to screen between crushing stages all or nearly all the fines from the coarse material, because merely scalping, that is, only partially screening the material, produces improved results.

When employing more than two crushing stages it may be found more economical to omit screening between certain stages and have screening between the other stages, that is, the screened material by-passes only some of the stages. It also might be found advantageous when crushing certain material in more than two stages to screen out between the first and second stages not only the fines that have been reduced to the final desired sizes but also the material that has been reduced to a size below the minimum clearance of the second crushing stage, allowing the succeeding screens to introduce the material larger than the final size to a succeeding crushing stage for further reduction.

In place of using a single screen, the well known principle of multiple deck screens may be employed so as to secure more efficient screening.

In order to have screening effective it is necessary to make the heads with sufficient openings through them to allow the screened product to readily drop through these openings to the space below that particular head. In this manner a part of the material passing through the crusher by-passes certain crushing stages.

In order to protect the heads from wear, especially at the openings through which the screened material drops, these exposed surfaces of the head should be lined with wear resisting material.

Placing these openings in the heads to allow screened material to drop through them also has the advantage that these gyrating heads can be made lighter.

In using screens between stages the material passing through the screens by-passes the crushing stage directly following the screen. This results in a multi-stage crusher in which the earlier stage or stages have more material passing through the crushing chambers than passes through the later stages in which the screens by-pass some of the material.

As the last stage of my multi-stage crusher may be used for producing quite fine material there is a decided advantage in removing the material already reduced to the desired fineness before the material enters the last stage. The material entering this stage has smaller voids than the material had in the previous crushing stages. If the fines already reduced to the final size or even smaller than the final size are permitted to enter the receiving opening of the last stage this fine material may fill up the voids existing between the material requiring crushing in that stage. This makes the final crushing more difficult, requires more power and produces still more fines of smaller size than the desired final degree of fineness. There is also the danger of producing packing of the material in this last stage, all of which could be largely prevented by screening the material before it enters the last stage of the crusher.

In a multi-stage gyratory crusher of my invention, I can also permit the crushing of two or more different sizes of material without having the finer material pass through the earlier stage or stages of the crusher. Finer material may be introduced through suitable openings in the frame of the crusher leading to later crushing stages, and thereby by-passing the earlier stages of the crusher. For example, many gyratory crushers of the present single stage type have oversized material discharged from them. The crushed material is screened and the oversized is returned to the crusher to be crushed over again. In a multi-stage crusher of my invention this oversized material can be returned to the inlet opening of the last stage through suitable openings in the frame of the crusher and crushed to the desired final size without having to be readmitted to the crusher with the initial coarse feed. This means that some of the material finally discharged by the crusher does not pass through all the crushing stages, the earlier crushing stages being by-passed.

I also provide suitable hand holes to permit taking out of samples of the crushed material between crushing stages so that the size of material produced by any stage may be determined. Naturally, these hand holes can also be used for visual inspection as, for instance, checking the discharge clearances between head and concave.

Screening the material between stages relieves certain crushing stages from being burdened with the full quantity of the material initially introduced into the crusher. This, in certain cases, permits reducing the diameter and area of crushing surfaces thereby reducing the over all dimensions of the crusher. There is also a saving in power by not having to crush material already to desired size to a still finer size.

An important object of my invention is the production of more finished product of the desired size and less product smaller than the desired size.

Another important object of my invention is to relieve any one crushing stage of crushing material already to the size of smaller than the size of the minimum discharge opening of that stage, thereby permitting the use of a crushing stage of smaller capacity.

Another important object of my invention is in decreasing the power consumption of the crusher chiefly because there is less power wasted in crushing below the desired degree of fineness.

An important advantage of my invention lies in the fact that the crusher can crush different sized materials without having the finer material pass through the earlier stages of the crusher, thereby also saving in power consumption.

Another important advantage of my invention lies in the fact that samples of crushed material may be obtained from between crushing stages so that if the minimum discharge clearance has been changed due to wear or other causes, this dimension can be reestablished.

Another advantage of my invention lies in the fact that suitable hand holes or peep holes permit of visual inspection of the crushing chambers even during the operation of the unit.

Another advantage of my invention is that it permits wet crushing in the latter stages of the crusher.

For a more detailed understanding of my invention reference is to be made to the following description and accompanying drawings of practical embodiments of the inventive idea, and in which drawings—

Fig. 1 is a part sectional view of a three stage

gyratory crusher showing particularly the crushing surfaces, the crushing chambers and the screen arrangements between stages.

Fig. 2 is a sectional view to an enlarged scale of the crushing surfaces and screen arrangements of a three stage gyratory crusher.

Fig. 3 is a sectional view along the lines 3—3 of Fig. 2.

Fig. 4 is a sectional detail view of the ribs or arms between the hub and rim of a gyrating head provided with screens, along the lines 4—4 of Figs. 2 and 3.

Fig. 5 is a sectional view like that of Fig. 2 except it shows the use of double deck screens.

Fig. 6 is a part sectional view of a two stage gyratory crusher having screens between the first and second stages for screening out finished product without using the conveying surfaces illustrated in the previous figures.

Fig. 7 is a part sectional view like Fig. 2 but showing the method of introducing between stages additional material to be crushed.

Fig. 8 is a part sectional view along the lines 8—8 of Fig. 7.

Fig. 9 is a sectional view along the lines 9—9 of Fig. 8 showing particularly in detail the design and location of hand holes or peep holes.

Referring to Fig. 1 the electric motor for driving the crusher is shown at 1. This motor drives the vertical shaft 2 through the coupling 3. The lower end of the vertical shaft 2 is fastened to an eccentric bushing 4. The outer surface of the eccentric bushing is journalled in a stationary frame 5, and the inner surface of the eccentric bushing rotates about the hollow gyrating shaft 6. This hollow gyrating shaft permits the driving shaft 2 to pass through it without contact, and carries the crushing heads 7, 8 and 9 on its enlarged tapered portion. The gyrating shaft 6 near its upper end is centered and pivotally mounted on a ball seated bearing 10, and is supported at its threaded upper portion by the nut 11. The motor 1 in turning the shaft 2 rotates the eccentric 4, which in turn oscillates the gyrating shaft 6 about its upper and centrally located pivot 10. The weight of the motor and that of all the rotating and gyrating parts are carried by the spider casting 12 mounted upon the stationary frame 13. Shaft 6 together with the conical heads 7, 8 and 9 can be raised or lowered by means of the adjusting nut 11. Frame 13 is suspended by a number of suspension wire ropes 14 from a fixed support above the crusher and not shown in the figure. Surrounding the crushing heads 7, 8 and 9 are concaves 15, 16 and 17. These concaves are in the form of a continuous ring casting and are separately mounted in the stationary supporting frame 13.

As shown in Fig. 1, and to an enlarged scale in Fig. 2, the clearance spaces between the crushing heads and their corresponding concaves of any stage are larger at their top than at their bottom or discharge ends. Material is introduced into the space at the top between the crushing head 7 and concave 15 and most of it is crushed to the size of the minimum clearance between this head and its concave at their discharge ends. The material is then guided by the chute or conveying surface 18. This conveying surface 18 is a part of the casting 19 fastened to the lower side of the head 7. Casting 19 has a centrally located opening 20 through which the material drops to the screen 21 mounted on the top of the succeeding head 8. The screens are made in several parts for ease of assembly. In the figure screen 21 is made in three parts. Screen 21 slopes outwardly, and as conveying casting 19 and screen 21 are gyrated and vibrated, material will move along surface 18 inwardly and along screen 21 outwardly to the receiving opening of the second stage of the crusher except the material which passes through the screen 21. The material passing through screen 21 drops through openings in the gyrating head 8 to the chute or conveying casting 22 below the head 8. Similarly material discharged from the second crushing stage is conveyed along the sloping surface 23 of the conveying casting 22 where it meets the material which dropped through the screen 21 and head 8. The entire material drops through the centrally located opening 24 upon the screen 25 fastened on the top of gyrating head 9. Here again the material is screened and the oversized passes to the receiving opening of the third crushing stage and that part of the material which passes through the screen 25 drops through the openings in head 9 directly to the discharge surface 26 and through the crusher discharge opening 27. The screens 21 and 25 and the conveying castings 19 and 22 are made of wear resisting material such as manganese steel. Protecting sleeves 28 and 29, made of wear resisting material, are placed over the gyrating shaft to protect it from wear.

Fig. 4 is a sectional view of the connecting rib through the head 8 along the lines 4—4 in Figs. 2 and 3. Fig. 4 shows the securing of screen 21 to the arms connecting the hub portion of the head 8 to the rim of head 8. The screen is fastened to the upper surface of the arms of the heads by screws 30 and the conveying casting is fastened to the lower surface of these arms by screws 31.

Fig. 5 is similar to Fig. 2 except that it shows the arrangement of two deck screens instead of the single screen arrangement of Fig. 2. Similar parts in the figures bear the same numbers, but the screen 21 in Fig. 2 is replaced by the double deck screen 21′ and 21″. Screen 25 of Fig. 2 is replaced by 25′ and 25″.

In Fig. 5 the material after being crushed in the first stage is conveyed by the chute or conveyor 19 to the inner diameter of the screen 21′. This screen is a coarser screen than 21″ and allows only part of the coarse material to pass through. The main oversized material passes over the screen 21′ and drops into the receiving opening of the second crushing stage. Screen 21″ only allows material equal to or smaller than the minimum discharge opening of the second stage to pass through it. This double deck screen arrangement permits the lower screen 21″ to do more efficient screening. Material which drops through screen 21′ and does not drop through 21″ is carried by the latter screen to the receiving opening of the second crushing stage. The discharge of the second stage drops to the screen 25′ and the material that is passed through screen 21″ drops through the head 8 on the inner portion of screen 25′. The double deck screens 25′ and 25″ function in a similar manner as do screens 21′ and 21″ except that the double deck screens between the first and second stage perform coarser screening than do the double deck screens between the second and third crushing stages. In the three stage crusher of Fig. 5 the screen 25″ permits material to pass through it that has reached at this point the desired final degree of fineness.

If the material being crushed is quite friable

and the screens 21'' and 28'' permit a sufficient quantity of fines to pass through them, thus by-passing the second and third crushing stages respectively, the diameter of the heads 8 and 9 and the corresponding concaves 16 and 17 can be made of smaller diameters thus reducing not only the size of the unit and hence its cost but it also decreases the power required for the crushing operation.

Fig. 6 shows a two stage crushing arrangement in which the chute or conveyor 19 in Fig. 1 is omitted permitting the material discharged from the first stage to drop directly onto the screen 21. Any material equal to or less than the desired final fineness can pass through the screen 21 and thereby by-pass the second crushing stage, and only material that requires more crushing passes to the entrance of the second stage where it is further crushed to the desired final degree of fineness.

It is obvious that some of the screens and their conveying surfaces in Figs. 1, 2 and 5 may be omitted should it be desired or preferable to do so. In place of the screens manganese steel conveying surfaces such as shown in my prior patent application above referred to should be substituted.

In Fig. 7 is shown a three stage crusher equipped with single deck screens and conveyors between the first and second stages and also between the second and third stages similar to the construction shown in Fig. 1. Fig. 7 also shows the manner in which material can be introduced directly into the second stage and into the third stage without having to pass through the preceding stages of the crusher, thus bypassing these earlier crushing stages. Such material as is to be introduced directly into the second stage is admitted to hoppers 32 and from them through openings 34 spaced circumferentially around the frame or casing 13 by which the material is fed directly into the receiving opening of the second crusher stage. Similarly material which is to be introduced to the third stage of the crusher is admitted into the hoppers 33 and from them through the openings 35 spaced circumferentially in the frame or casing 13, and fed directly into the receiving opening of the third crusher stage.

In Fig. 3, which is a cross section along the line 8—8 of Fig. 7, it shows these hoppers and openings through the frame at four places about the circumference of the crusher.

In Fig. 9 a partial sectional view of Fig. 1 is presented showing the position of hand holes 36 and 37. Hand hole 36 is shown placed in line of the discharge opening of the first crushing stage, and hand hole 37 is shown in line of the discharge opening of the second crushing stage. These hand holes will permit an operator to remove samples of crushed material at these points. They also can be used for inspection purposes, and when properly piped water for wet crushing can be introduced at these points. In Fig. 8 two hand holes 36 are shown placed opposite each other and two hand holes 37 are also shown placed opposite each other.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention together with the apparatus which I now consider to represent the best embodiments thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is,

1. In a multi-stage gyratory crusher, a gyrating shaft, a number of conical shaped heads mounted on said shaft, suitable stationary ring shaped concaves surrounding each of said heads and cooperating with them so as to form definite crushing stages of increasing diameters from the top downward, suitable gyrating conveying surfaces between one or more stages for conveying the crushed material discharged from a stage to an opening of smaller diameter than the discharge diameter of the preceding stage, suitable gyrating screens mounted on the top of the succeeding head so designed and constructed that it receives the crushed material from the said conveying surfaces and permits a substantial part of the material crushed to a finer size than the minimum clearance of the succeeding stage to pass through suitable openings in the said head, and guiding the remainder of the crushed material to the receiving opening of the succeeding stage.

2. In a multi-stage gyratory crusher, a gyrating shaft, a number of crushing heads mounted on said shaft, stationary concaves surrounding each of said heads and coacting with them so as to form a number of crushing stages of increasing diameters and decreasing discharge openings from the top downward, gyrating conveying surfaces, slightly inclined from the horizontal and extending inwardly and downwardly, mounted on the discharge end of some of the heads, suitable gyrating screens directly below each of the said conveying surfaces and inclined outwardly and downwardly at slight angles of inclination to the horizontal and mounted on the tops of the next succeeding crushing heads, each of said screens having openings equal to or less than the minimum width of discharge opening of the crushing stage immediately below the screens, and the crushing heads immediately below the screens having suitable vertical openings through them for by-passing crushed material passing through the screens to the next succeeding crushing stage, whereby all the crushed material discharged by a crushing stage is guided by the conveying surface to the screen below and the fines by-pass the next crushing stage and the coarse material is guided by the screens to the inlet opening of the next crushing stage.

3. In a multi-stage gyratory crusher, a gyrating shaft, a plurality of crushing heads mounted on said shaft, stationary concaves coacting with said heads to form successive crushing stages of increasing diameters from the intake to the final discharge of the crusher, conveying surfaces positioned beneath the discharge of the stage or stages preceding the final crushing stage to receive the material discharged from the next preceding stage, means connecting said conveying surfaces to said gyrating shaft whereby the conveying surfaces will be gyrated, screens between the discharge of said gyrating conveying surfaces and the inlet of the succeeding crushing stage, said screens having openings therein equal to or less than the minimum discharge opening of the succeeding crushing stage, said crusher provided with passage-ways leading from beneath the screens past the discharge of the succeeding stage to by-pass material falling through the screens.

4. In a multi-stage gyratory crusher, a gyrating shaft, a plurality of crushing heads mounted on said shaft, stationary concaves coacting with said heads to form successive crushing stages of increasing diameters from the intake to the final

discharge of the crusher, conveying surfaces positioned beneath the discharge of the stage or stages preceding the final crushing stage to receive the material discharged from the next preceding stage, means connecting said conveying surfaces to said gyrating shaft whereby the conveying surfaces will be gyrated, screens between the discharge of said gyrating conveying surfaces and the inlet of the succeeding crushing stage, said screens having openings therein equal to or less than the minimum discharge opening of the succeeding crushing stage, the next succeeding crushing heads below said screens having vertical passages through them for receiving the material passing through the screens thus by-passing such material past the crushing stage next succeeding the screen, said screens being inclined from the discharge of the conveying surfaces to the inlets of the succeeding stages whereby the material delivered upon the screen which does not pass through it will be delivered to the succeeding crushing stage.

5. In a multi-stage gyratory crusher, a gyrating shaft, a plurality of crushing heads mounted on said shaft, stationary concaves coacting with said heads to form successive crushing stages of increasing diameters from the intake to the final discharge of the crusher, conveying surfaces positioned beneath the discharge of the stage or stages preceding the final crushing stage to receive the material discharged from the next preceding stage, means connecting said conveying surfaces to said gyrating shaft whereby the conveying surfaces will be gyrated, screens between the discharge of said gyrating conveying surfaces and the inlet of the succeeding crushing stage, said screens having openings therein equal to or less than the minimum discharge opening of the succeeding crushing stage, the next succeeding crushing heads below said screens having vertical passages through them for receiving the material passing through the screens thus by-passing such material past the crushing stage next succeeding the screen, said screens being inclined from the discharge of the conveying surfaces to the inlets of the succeeding stages whereby the material delivered upon the screen which does not pass through it will be delivered to the succeeding crushing stage, said screens being connected to said gyrating crushing heads for gyratory movement therewith.

6. In a multi-stage gyratory crusher, a gyrating shaft, a plurality of crushing heads mounted on said shaft, stationary concaves coacting with said heads to form successive crushing stages of increasing diameters from the intake to the final discharge of the crusher, conveying surfaces positioned beneath the discharge of the stage or stages preceding the final crushing stage to receive the material discharged from the next preceding stage, means connecting said conveying surfaces to said gyrating shaft whereby the conveying surfaces will be gyrated, said crushing heads subsequent to the crushing head of the first crushing stage being provided with passages therethrough opening out beyond the discharge of the respective stage, screens over the inlet ends of said passages for receiving thereon the material discharged from the preceding stage, said screens shaped to form a conveying surface to convey material delivered thereon which does not pass through the screens to the inlet of the crushing stage while the material falling through the screens passes through the passage in the crushing head.

7. In a multi-stage gyratory crusher, a gyrating shaft, a plurality of crushing heads mounted on said shaft, stationary concaves coacting with said heads to form successive crushing stages of increasing diameters from the intake to the final discharge of the crusher, said crushing heads having imperforate crushing surfaces and the heads subsequent to the crushing head of the first crushing stage being provided with passages therethrough opening out beyond the discharge of the respective stage, screens carried by said crushing heads and gyrating therewith, said screens being positioned over the inlet ends of said passages for receiving thereon the material discharged from the preceding stage, the material falling through said screens being by-passed through said passages past the succeeding crushing stage, said screens shaped to form a conveying surface to convey material delivered thereon which does not pass through the screens to the inlet of the succeeding crushing stage.

8. In a multi-stage gyratory crusher, a gyrating shaft, a plurality of crushing heads mounted on said shaft, stationary concaves co-acting with said heads to form successive crushing stages of increasing diameters from the intake to the final discharge of the crusher, said crushing heads having imperforate crushing surfaces and the heads subsequent to the crushing head of the first crushing stage being provided with passages therethrough opening out beyond the discharge of the respective stage, double-deck screens positioned over the inlet ends of said passages for receiving the material discharged from the preceding stage, said double-deck screens arranged in pairs carried by each crushing head subsequent to the crushing head of the first crushing stage and being shaped to form conveying surfaces for delivering material which does not pass through the screens to the inlet of the succeeding crushing stage, said double-deck screens indirectly connected to said shaft for gyrating movement therewith.

9. A gyratory crusher having two or more crusher heads mounted on a gyrating shaft and having each crusher head surrounded by a suitable stationary concave so arranged and constructed that each crusher head together with its corresponding concave forms a definite crushing stage so that the material to be crushed passes successively from one crushing stage to another where it is consecutively crushed to a finer size, and having each successive crushing stage so designed and constructed that it has its entire crushing surface of substantially greater diameters than those of the preceding stage, and having movable non-crushing means for conveying the material to be crushed from one stage of small diameter to the succeeding stage of materially larger diameter, said movable non-crushing conveying means being perforated to form screens to permit fines to fall therethrough, said crusher provided with passages to receive the fines falling through the perforated conveying means to by-pass the fines past the succeeding crushing stage.

SHELDON STEARNS.