# United States Patent

[11] 3,561,685


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[54] **CENTER FED MILL WITH ARCUATE DISCHARGE SCREENS**
**7 Claims, 5 Drawing Figs.**


[52] **U.S. Cl.** ..... **241/55,** 241/73, 241/189, 241/242
[51] **Int. Cl.** ..... **B02c 13/13,** B02c 18/44
[50] **Field of Search** ..... 241/18, 27, 15 (Cursory), 55, 66, 73, 74, 189, 190, 242, 275, 285–290, 239, 241, 65(Cursory), 188, 241–243



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,666,798 | 4/1928 | Taggart | 241/73 |
| 2,145,175 | 1/1939 | Hauge | 241/65X |
| 2,381,775 | 8/1945 | Roddy | 241/73 |
| 2,546,286 | 3/1951 | Zakel | 241/55X |
| 2,986,347 | 5/1961 | Stevenson | 241/73X |
| 3,090,568 | 5/1963 | Wetmore | 241/73 |
| 3,419,223 | 12/1968 | Morin | 241/73 |
| 3,436,025 | 4/1969 | Sheldon | 241/55X |
| 2,726,045 | 12/1955 | Hinerfeld | 241/16 |



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**ABSTRACT:** Material, particularly thermoplastic material, for example polyethylene, is subjected to size reduction in a mill in which it is projected by an impeller against one or more cutter plates closely spaced from the impeller. The working of the material is continued until it is reduced to the extent that it passes through a screen disposed in the mill housing.

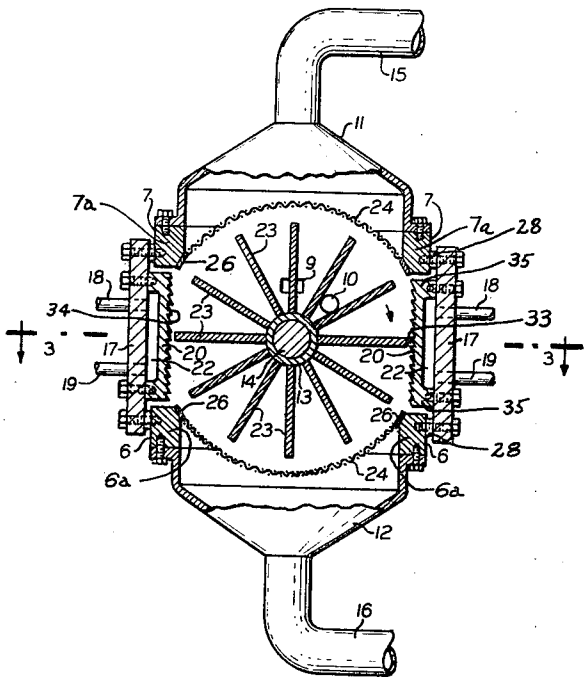



FIG. 1.

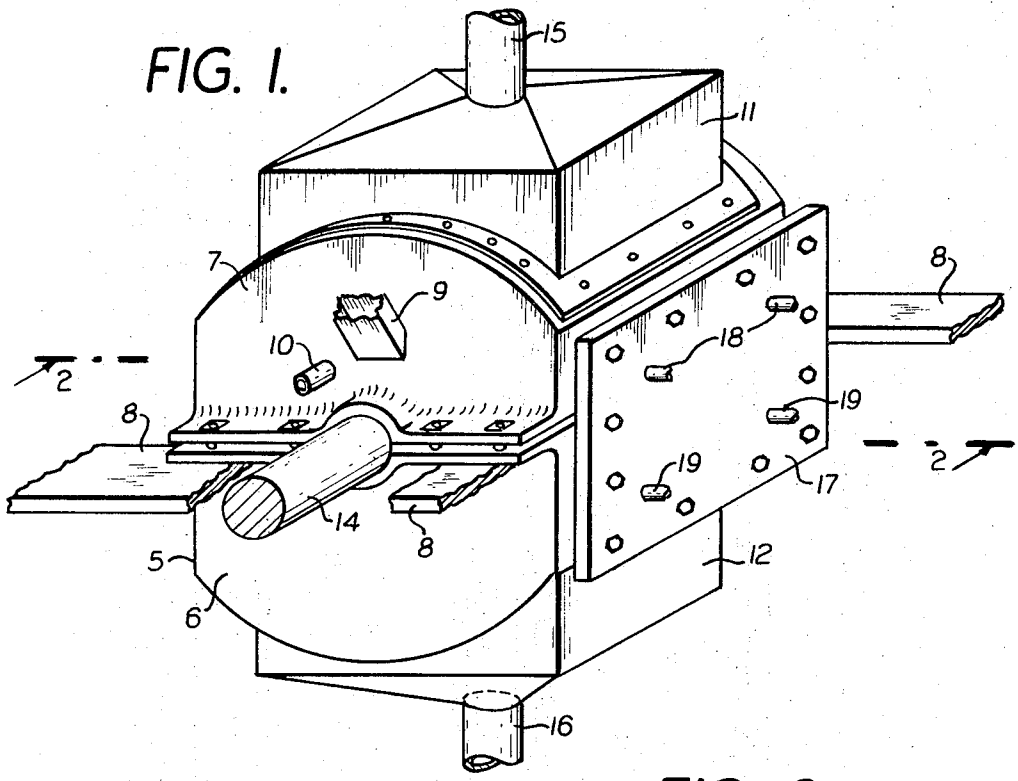
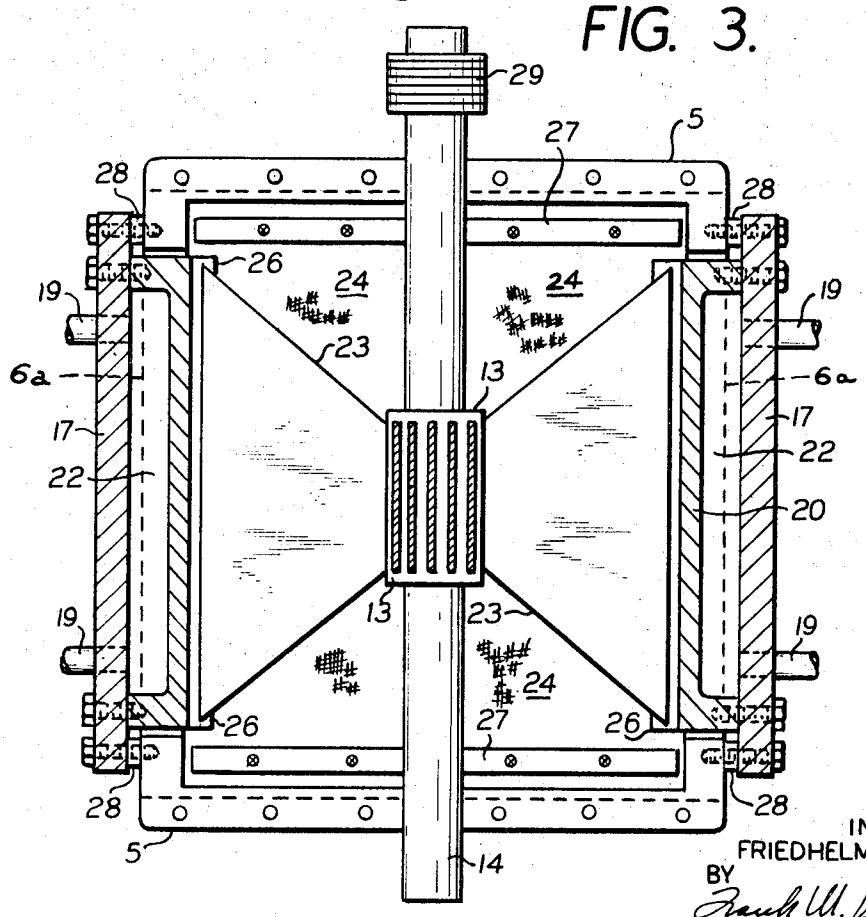



FIG. 3.




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FIG. 2.

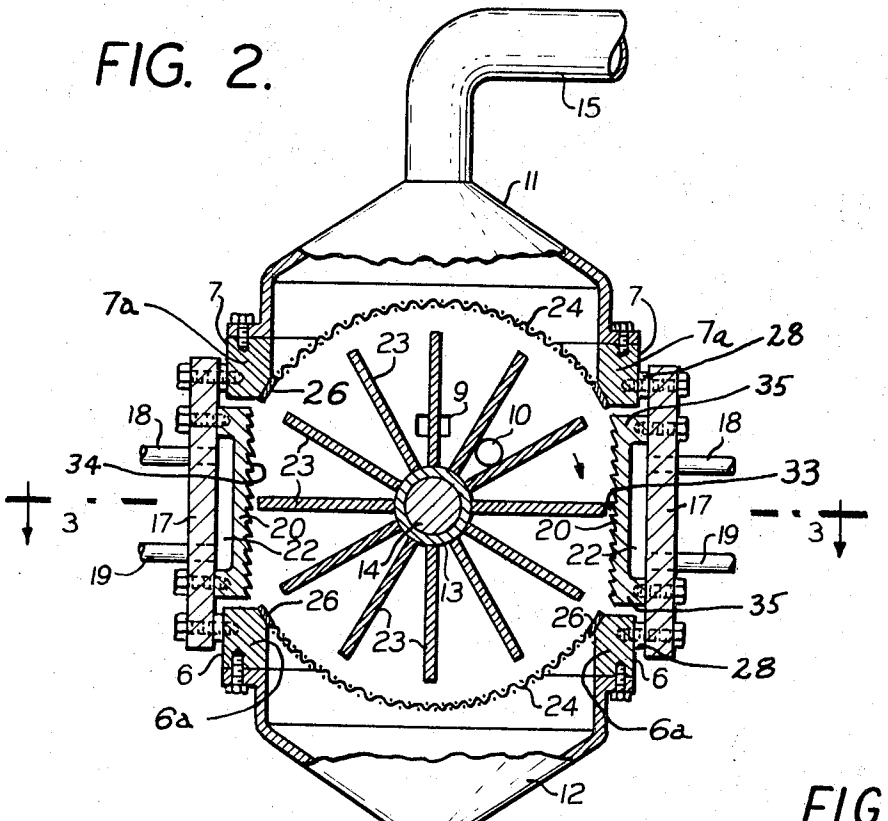



FIG. 5

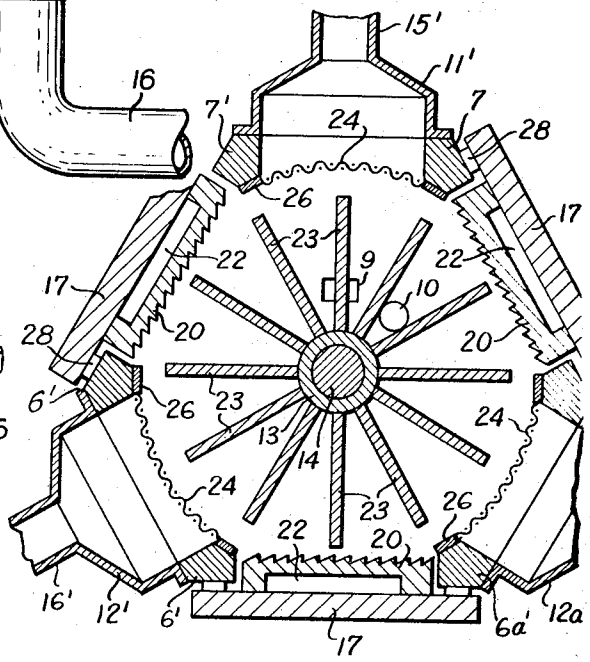
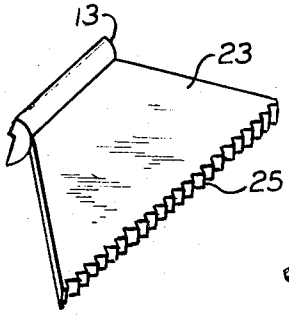



FIG. 4.




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# CENTER FED MILL WITH ARCUATE DISCHARGE SCREENS

## CROSS-REFERENCE TO RELATED APPLICATION

This application is directed to an improvement on the invention disclosed in copending application of the applicant herein, Ser. No. 588,819, filed Oct. 24, 1966, now Pat. No. 3,428,260, issued Feb. 18, 1969.

## BACKGROUND OF THE INVENTION

Thermoplastics are produced by the primary producer as pellets of size in the order of one-fourth inch diameter. In many applications, such as rotational molding, rug backing, it is desired to use the material in much finer condition. Accordingly, various procedures have been employed for size reducing the pellets. A problem is the heat sensitiveness of the material, since in general the size reducing unit operations produce more heat than the material can stand. One solution to the problem was to effect the size reduction in a cold medium, in particular, liquid nitrogen. The resort to such an extreme indicates the seriousness of the problem. Another procedure has been to carry out the reduction in an airstream, relying on the air for cooling. By and large, the approach in utilizing air has been to use equipment of the type, e.g. disc grinders, used for size reduction of wood.

The instant invention utilizes air for cooling, but employs apparatus which, as far as is known, is novel, and is specially designed for the task which is the concern of the invention.

The service requires not only suitable cooling but also the production of a product having good flow properties. The invention meets this requirement.

A significant advantage of the invention is dependability of operation. Thus, in the prior art where, as mentioned above, known size reduction equipment is used, whereas satisfactory operation may be realized for substantial periods, yet at times overheating occurs with the result that the material melts forming a mass within the machine, and necessitating shutdown. This situation has prompted modifications of existing equipment directed to obviating the difficulty. See, for example, my U.S. Pat. No. 3,302,893, assigned to the assignee hereof.

The invention of the aforementioned application, Ser. No. 588,819 is more dependable in the respects mentioned above, and can be operated at a predetermined capacity with less likelihood of occurrence of overheating.

Another advantage of the invention is that the product produced has good flow properties. The flow properties are particularly significant in the use of the fine material. In rotational molding for example, the flowability of the fine material is critical, in production of articles of complicated shapes. The flow properties depend on the surface character and density of the particles, and those properties, particularly, the surface character are affected by the manner of size reduction and the heating of the particles. No doubt the mere breaking of the particles to size reduce, impairs flowability. Such heating as occurs, on the other hand, would tend to melt the plastic at the surface, and thereby improve flow properties. The flowability of the product is particularly good and is superior to that generally obtained by reducing with the commonly used disc mills. For many applications, the product can be used directly without a special polishing treatment, as is commonly employed with the product from disc mills. Still another advantage is that it commonly permits open circuit operation, whereas, for the same job, prior art procedures would require closed circuit operation. Thus, commonly, the necessity for classifying and recycling is obviated.

The apparatus of the instant invention has the advantages mentioned above for the apparatus of the copending application, Ser. No. 588,819, and, further, is an improvement on my said prior machine. Whereas my prior machine is composed of a cylindrical impeller, and, for example, two rotating cylindrical cutters in diametrically opposed relation with respect to the impeller, according to the instant invention, the cutters are



flat, stationary plates. The new construction facilitates manufacture and simplifies adjustment of the cutters. Further, it is possible to have greater screen area. This results in not only better screening, but also improved cooling. Also, there is less heat build up, particularly where the material does not break down readily so that the residence time is long. Still another advantage is that with the instant invention, the working area of the cutter is more effectively utilized. Thus, in my prior machine, the working surface of the cutter is disposed in convex relation to the impeller, while in the improved version, with the working surface of the cutter being flat, there is a better presentation of the cutting teeth on the working surface, to the action of the impeller. The construction of the invention can also be compared to a design wherein the working surface of the cutter is concave with respect to the impeller, as would be the case in a machine wherein the working surface is disposed along a cylinder which is concentric with the path of the impeller. In construction as just mentioned, the "first" teeth (those which the respective impeller blades pass first upon each passing of the impeller blades) do most of the work. In the construction in the instant invention, the work is well distributed over a much larger portion of the working surface. A further advantage is that the noise level of the newest machine is lower.

It is surprising that the rotating cutters of my prior machine can be replaced with flat cutter plates.

It is surprising that when flat plates are used that the teeth do not fill up, and stay clean.

## SUMMARY OF THE INVENTION

The invention provides a mill comprising a rotatably mounted impeller for projecting particles of the material to be size reduced outwardly of the path of the impeller blades as a dispersion of the particles. A cutter having a substantially flat working surface with cutting teeth formed therein is disposed tangentially with respect to the path of the impeller blades. The circumferentially spaced ends of the cutter are spaced a substantial distance from the locus of tangency, and connect with the internal surface of the mill housing. The contour of the internal surface of the housing where it connects with the cutter ends, is concave so that movement of the dispersion to and from the cutter occurs without deposit of material from the dispersion. A screen is mounted in the housing for screening of the dispersion. Desirably, the screen forms an axially extending portion of a cylinder coaxial with the impeller, and the cutter is a chord of the cylinder.

Desirably, the mill includes a plurality of cutters as aforesaid, disposed at spaced intervals about the impeller path, and in such embodiments a screen can be, and preferably is, disposed in the intervals between the cutters. As large a screen area as is possible is desirable since better cooling results.

The cutter can be, and preferably is, stationary. This simplifies the construction.

## BRIEF DESCRIPTIONS OF THE DRAWINGS

The invention is illustrated in the accompanying drawings, wherein an embodiment thereof is depicted. In the drawings:

FIG. 1 is a perspective view of the machine;

FIG. 2 is an end elevation, partially in cross section along line 2–2 in FIG. 1;

FIG. 3 is a horizontal cross section taken along line 3–3 in FIG. 2;

FIG. 4 is a perspective view of a portion of the impeller, particularly showing the construction of the teeth of the impeller blades; and

FIG. 5 indicates an alternative construction.

The mill illustrated in the drawings comprises a housing 5 composed of a lower shell 6 and upper shell 7. The housing is supported in any suitable manner as by planking 8. Access to the internal parts can be obtained by removing the upper shell 7. The shaft 14 on which the impeller 13 is mounted can be

journaled on each side of the housing. In an alternative and preferred construction, the housing, instead of being formed of lower and upper shells, is formed of a single piece and the mounting of the impeller on the motor drive is an overhung mounting. This construction permits providing for access by constructing the end of the housing remote from the motor as a hinged door, which can be opened to expose the internal parts.

The housing 5 is provided with air inlet 10 and feed inlet 9 for center feeding of the material, as shown in FIG. 1 and FIG. 2. Cutter plates 20 (FIG. 2) are mounted on base plates 17, which in turn are mounted on the housing. Cooling water passageways 22 are provided for cooling of the cutters, and cooling water inlet pipes 18 and outlet pipes 19 pass through the base plate 17, communicating with the cooling passage way. The size reduced material, having passed through screens 24, enters either the lower hood 12 or the upper hood 11, and then, being conveyed by air pumped by the impeller, enters the outlet pipes 16 or 15.

As can be best seen in FIG. 2, the cutters 20 have flat working surfaces with cutting teeth 34 formed therein. The construction of the cutting teeth can be that disclosed in copending application Ser. No. 588,819 for the cutter shown in FIG. 6 of that application. The cutters are spaced from the path of the impeller a small distance, for example 0.040 inches, and are disposed tangentially with respect to the path of the impeller blades, i.e. in tangential relation with a cylinder concentric with the cylindrical path of the impeller and of radius equal to a radius of the impeller plus the clearance between the impeller and the cutter. The cutter terminates in circumferentially spaced ends 35 which are each spaced a substantial distance from the locus of tangency 33. The circumferentially spaced ends 35 connect with the internal surface of the housing, i.e. with the elongated housing member 6*a* and 7*a*. The contour of the internal surface of the housing where it connects with the cutter end is concave so that movement of the dispersion to and from the cutter occurs without deposit of material from the dispersion.

Screens 24 substantially bridge the interval between the cutters. A large screen area is desirable as it results in improved cooling, and, of course, rapid removal of suitably small particles from the size reducing zone. Accordingly, the elongated housing members 6*a* and 7*a* are made as small as possible in the circumferentially extending direction.

The screens 24 are smooth surfaced as shown in FIG. 2, and are disposed over a cylindrical surface concentric with, but spaced from the path of the impeller. This spacing is sufficient so that substantial cutting is not caused by impingement of particles against the screen, and so that the screen is in an area wherein the particles are still well dispersed in a dispersion. Desirably, the cutters are disposed as chords of the cylinder over which the screens are disposed. The screen is secured in place by holddown straps 26 (FIG. 2) and 27 (FIG. 3).

The positioning of the cutters 20 can be adjusted by shims 28 (FIG. 3). A pulley drive wheel 29 is mounted on the shaft 14 (FIG. 3).

FIG. 4 indicates a preferred construction for the outer ends of the impeller blades 23. The outer end of each blade is a short circumferentially extending portion of a screw thread. This construction is suitable and economical. It provides good cutting action.

FIG. 5 shows an embodiment having more than two cutter plates 20. Like reference characters indicate corresponding parts with primed figures indicating parts of corresponding function but different configuration.

The mill of the invention is particularly well suited for size reducing thermoplastics, for example polyethylene and polypropylene. It is especially well suited for production of a relatively course product, having a low content of fines. For example, the machine can be used to process low density polyethylene, having a m.i. of 20, and a density of 0.922, to produce a product which is 100 percent −20 mesh. About 60 percent of this material would be between −30 mesh and +30 mesh; the total −50 mesh would be approximately 10 percent; and there would be less than 2 percent—100 mesh. The size reduced polyethylene is well suited for use as rug backing material. In this example the screen should be a conventional woven screen having square openings 0.040 × 0.040 inches, or, alternatively a perforated plate having circular openings of diameter about 0.062 inches. The mill can have an impeller 18.5 inches in diameter, 18 inches long, with 12 blades; the screens can be 20.5 inches in diameter; 2 cutters; and an impeller speed of 3000 r.p.m.

A machine of larger diameter and lower impeller length performs at a lower noise level. Such a machine can have an impeller 32 inches in diameter, 12 inches long, with 24 blades; screen diameter 33 inches; 3 cutters; impeller speed, 1800 r.p.m.

A smaller mill than those described above is desirable for some services. Thus, for producing a −30 mesh product in a single pass, the mill can be outfitted with an impeller 18 inches in diameter and 6 inches long, with 16 blades; screen diameter 20 inches; impeller speed, 4000 r.p.m. Such a machine could be utilized to produce material well suited for use in rotational molding.

## OPERATING EXAMPLE

Apparatus of the construction shown in the drawing having an 18.5 inch diameter impeller and 20.5 inch diameter screens was used to size reduce low density polyethylene in an open circuit, from pellets about one-eighth inch in diameter to small size particles −18 mesh. The throughput is 900 lbs. per hour. The impeller is driven at 3000 r.p.m. by a 100 horse-power motor. The product is well suited for use as carpet backing.

While the invention has been described with respect to particular embodiments thereof, these embodiments are merely representative and do not serve to define the limits of the invention.

I claim:

1. Apparatus for size reduction of material which comprises:

a. an impeller, means for rotating the impeller, said impeller having impeller blades, said means for rotating the impeller moving the blades through a path, said impeller blades being for projecting particles of the material to be size reduced outwardly of the path of the impeller blades as a dispersion of the particles;

b. a housing for the impeller, said housing having an internal surface and an inlet for center feeding of the material to the mill;

c. a plurality of stationary cutters each having a substantially flat working surface with cutting teeth formed therein, disposed at spaced intervals about the impeller path;

d. a smooth surfaced screen forming an axially extending portion of a cylinder coaxial with the impeller, mounted in the housing for screening of the dispersion;

e. the cutters being disposed tangentially at a locus of tangency with respect to the path of the impeller blades terminating in circumferentially spaced ends each spaced a substantial distance from the locus of tangency and connecting with the internal surface of the housing, the cutters being chords of said screen cylinder; and

f. the contour of the internal surface of the housing where it connects with said cutter ends being concave so that movement of the dispersion to and from the cutter occurs without deposit of material from the dispersion.

2. Apparatus according to claim 1, comprising a plurality of said screens disposed at spaced intervals about the impeller path as aforesaid, said screens each comprising an axial extending portion of a cylinder coaxial with the impeller.

3. Apparatus according to claim 2, and the screens being disposed in the intervals between the cutters.

4. Apparatus according to claim 3, comprising two cutter plates diametrically opposed, said screens substantially bridging the intervals between the cutters.

5. Apparatus according to claim 3, comprising three cutter plates at equally spaced intervals, said screens substantially bridging the intervals between the cutters.

6. Apparatus according to claim 1, said screen substantially bridging the interval between the cutters.



7. Apparatus according to claim 2, said screen substantially bridging the interval between the cutters.

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# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,561,685 Dated Feb. 9, 1971

Inventor(s) Friedhelm R. Feder

It is certified that error appears in the above-identified pa and that said Letters Patent are hereby corrected as shown below:

Col. 3, line 75, change "+30" to --+40--.

Signed and sealed this 21st day of December 1971

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Pat