May 8, 1956 C. M. PARSHALL ET AL 2,744,287

MILL

Filed Sept. 24, 1952 2 Sheets-Sheet 1

Fig. 2

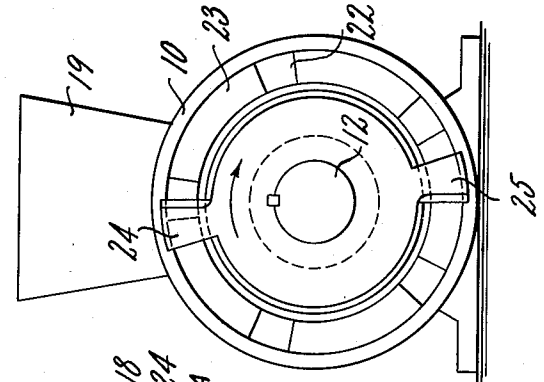
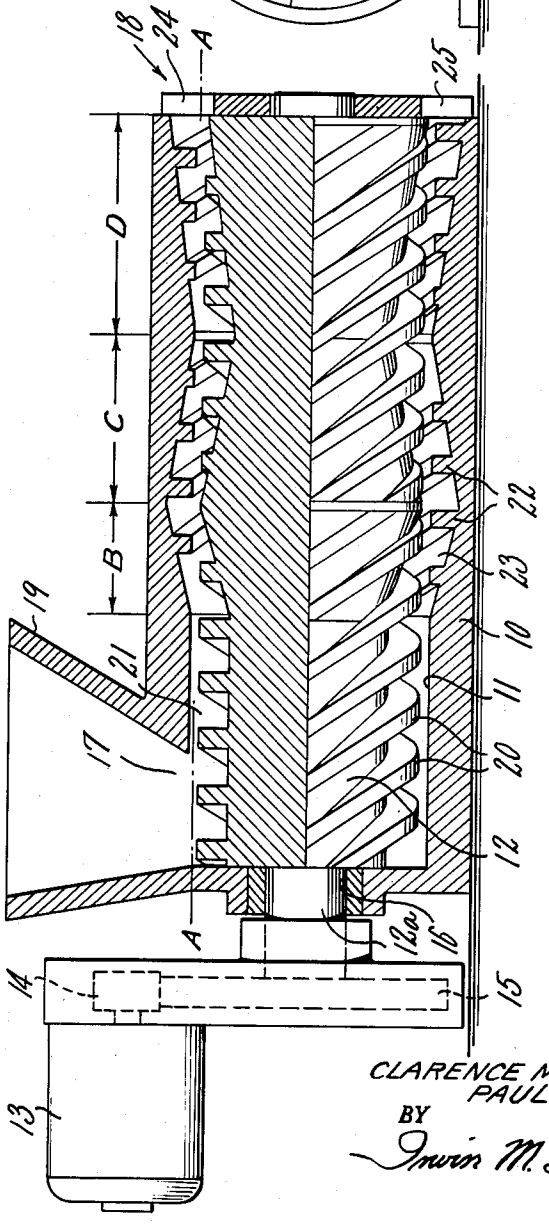



Fig. 1




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May 8, 1956 C. M. PARSHALL ET AL 2,744,287

MILL

Filed Sept. 24, 1952 2 Sheets-Sheet 2

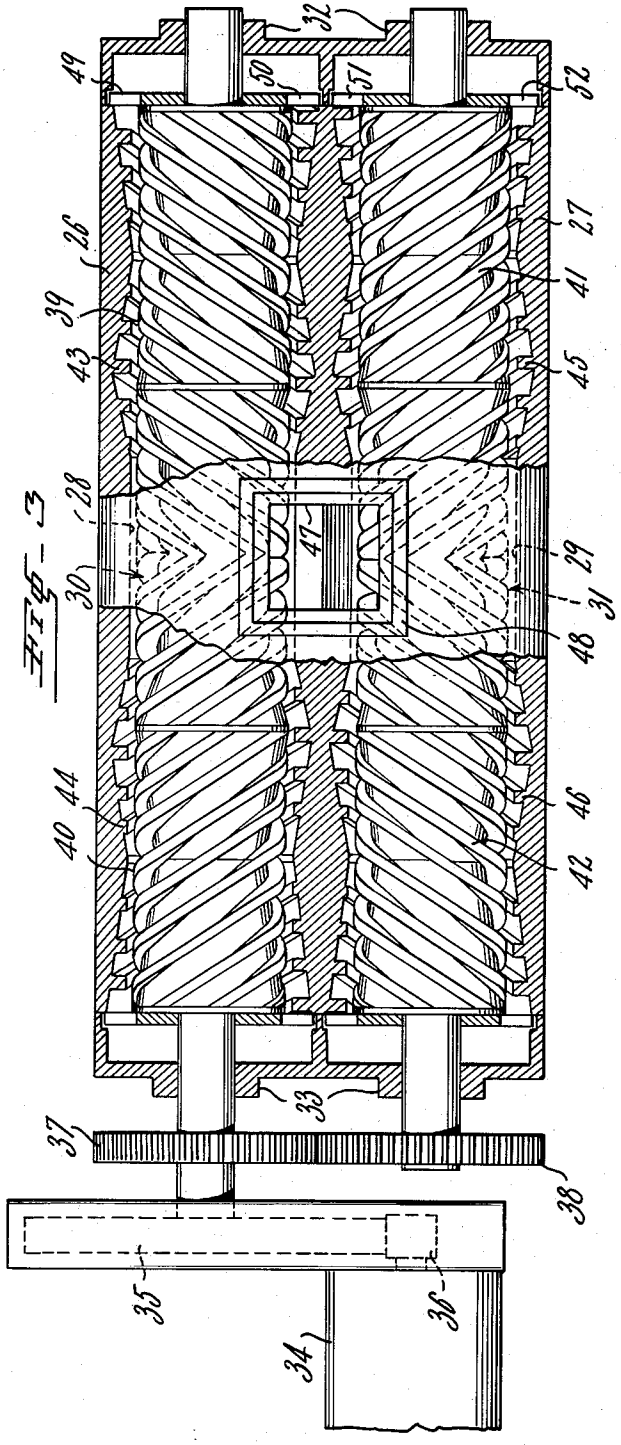


Fig. 3

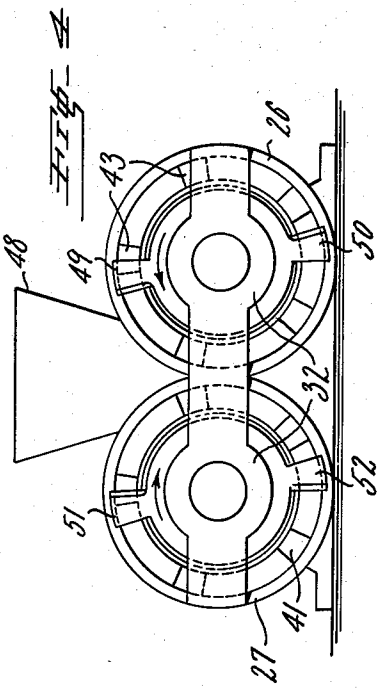


Fig. 4

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United States Patent Office

2,744,287

Patented May 8, 1956



2,744,287

# MILL

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Application September 24, 1952, Serial No. 311,243

8 Claims. (Cl. 18—12)

This invention relates to mills for mixing and working rubber-like compounds, and more particularly the invention relates to improvements in screw or worm type mills.

Conventional mills of this type heretofore used included a rotor and a tube or barrel in which the rotor was adapted to be rotated. The rotor was in the form of a continuous worm or screw which when rotated served to force the stock through the barrel. The stock was carried in the grooves formed between the threads of the screw or worm and the stock was mixed and worked by the intensive shearing action developed in the clearance between the barrel and the crest of the threads. A disadvantage of conventional mills of this type was that center portions of the stock carried in the grooves between the threads were often never subjected to the shearing action with the result that lumps of unmixed, unworked stock would work their way through the mill.

It is, therefore, an object of the present invention to provide a screw or worm type mill which will subject all the stock to the shearing action between the rotating rotor and the stationary barrel and thereby eliminate the possibility of unmixed, unworked lumps working their way through the mill.

Another object is to provide a mill which will mix and work all portions of the stock uniformly so that all portions of the stock will be mixed and worked substantially the same amount.

Another object of the invention is to provide a screw or worm type mill having grooves in the bore of the barrel through which the stock is discharged so that the stock may be cut into pellets as it is discharged through the grooves by rotating knives secured to the end of the rotor.

To accomplish the above objects, both the rotor and the barrel of the mill of the present invention are provided with grooves in which the stock may be carried. The grooves are so proportioned and related that all the stock in its passage through the mill must pass from the grooves in the rotor to the grooves in the barrel or vice versa. By this construction it is insured that all the stock will pass through the shear plane developed between the rotor and the barrel and be thoroughly mixed and worked thereby.

Other objects and advantages of the invention will become apparent from the following description when read in conjunction with the accompanying drawings, wherein:

Fig. 1 is a sectional elevational view of a single ended, single barrel mill embodying the present invention;

Fig. 2 is an end view of the discharged end of the mill of Fig. 1;

Fig. 3 is a plan view with parts broken away to show interior details of a double ended, double barrel mill embodying the present invention; and

Fig. 4 is an end view of the mill of Fig. 3.

Referring to the drawings and in particular to Figs. 1 and 2 of the drawing, there is shown one embodiment of the invention. This embodiment includes a barrel 10 having a bore 11 extending therethrough. A rotor 12



is rotatably mounted in the bore 11. The rotor 12 is adapted to be rotated by means of a motor 13 which is coupled by means of reduction gears 14 and 15 to an extension 12*a* of the rotor 12 which extends through an opening 16 in the end of the barrel.

The barrel 10 is provided with an opening 17 in the top thereof remote from the discharge end 18 of the barrel 10 through which stock to be mixed may be introduced into the mill. A funnel shaped hopper 19 surrounds the opening 17 to facilitate introduction of the stock.

The rotor 12 is provided with helical threads 20. Stock introduced through the opening 17 occupies grooves 21 formed between the threads 20 and rotation of the rotor 12 in the direction of the arrow in Fig. 2 forces the stock towards the discharge end 18 of the barrel 10. Mixing and working of the rubber is accomplished by the intensive shearing action developed in the clearance between the crest of the threads 20 and the surface of the bore 11 as the stock is moved towards the discharge end 18 by rotation of the rotor 12. This area of shear may be defined as a cylindrical shear plane which contains the line A—A of Fig. 1. It can be seen that if the threads 20 are of constant depth throughout the length of the rotor 12 that only surface portions of the stock carried in the grooves 21 between the threads are subjected to the intensive shearing action with the result that center portions of the stock may work their way through the mill without being mixed or worked. This is eliminated in the present invention by decreasing the depth of the threads 20 to substantially zero depth at some point along the length of the rotor 12 and by providing helical threads 22 of increasing depth in the bore 11 along a co-extensive portion. By this construction, all the stock in passing through the mill is transferred from the grooves 21 between the threads 20 in the rotor 12 to grooves 23 formed between the threads 22 in the bore 11 so that all the stock must pass through the shear plane and be thoroughly mixed and worked thereby.

In Fig. 1, the threads 20 are gradually decreased in depth to substantially zero depth through the distance B. Corresponding helical threads 22 in the bore 11 gradually increase in depth from a zero depth over the same distance B. It can be seen, therefore, that all the stock in its passage through the distance B must pass from the grooves 21 between the threads 20 to the grooves 23 formed between the threads 22 in the wall of the bore 11 and in so doing must pass through the shear plane identified by the line A—A.

In the apparatus of Fig. 1, the stock is passed through the shear plane three times before it is discharged, once through distance B as above described; once through distance C in which the threads 22 of the bore 11 gradually decrease to zero depth and the threads 20 of the rotor 11 increase in depth and once through the distance D in which the threads 20 gradually decrease to zero depth and threads 22 gradually increase in depth. It can be seen, therefore, that though neither grooves 21 nor 23 alone form a continuous passage through the mill that together they do form a continuous passage which intersects the shear plane A—A so that all the stock must pass through the shear plane.

It is to be understood that variations can be made in this arrangement. For example, the threads 20 of the rotor 12 could be continued full depth through distances B and C and the threads 22 in this distance eliminated with the result that the stock will pass through the shear plane only once in the distance D and be extruded through the ends of the grooves 21 which are open at the discharge end of the barrel as shown in Fig. 2. On the other hand, the threads 20 of the rotor 12 could be continued full depth through the distance D and the threads 22 in this distance eliminated in which case the stock would

pass through the shear plane twice, once in the distance B and once in the distance C and then be extruded out the end of the rotor.

The provision of the decrease in depth of the threads **20** of the rotor and the provision of threads **22** of gradually increasing depth in the bore **11** at the discharge end of the mill as in the distance D of Fig. 1 provides an additional advantage. The open ends of the grooves **23** between the threads **22** in the bore **11** provide stationary orifices at the discharge end of the mill, as best shown in Fig. 2, through which the stock is extruded. By securing knives such as shown at **24** and **25** to the end of the rotor **12**, the stock extruded from the open ends of the grooves **23** may be cut into pellets as the rotor **12** is rotated. Cutting the stock into small pellets facilitates handling of the mixed stock.

While the invention has been above described as incorporated in a single barrel, single ended mill, it is to be understood that the invention can be incorporated in double ended, single barrel mills; single ended, double barrel mills; or double ended, double barrel mills.

Figs. 3 and 4 show the invention incorporated in a double ended, double barrel mill. As the name implies, this mill has two barrels **26** and **27**, providing two parallel bores **28** and **29**. Two helically threaded rotors **30** and **31** are mounted for rotation in bores **28** and **29**, respectively, and are supported for rotation in bearings **32** and **33** secured to but spaced from the ends of the barrels. Spacing of the bearings **32** and **33** from the ends of the barrels **26** and **27** allows stock to be discharged from both ends of each barrel. The rotors **30** and **31** are adapted to be rotated in opposite directions as indicated by the arrows in Fig. 4 by a motor **34** which is coupled to one end of rotor **30** through reduction gears **35** and **36**. Rotor **31** is driven in the opposite direction from rotor **30** by means of meshing gears **37** and **38** secured to rotors **30** and **31** respectively.

Rotor **30** is provided with two sets of helical threads **39** and **40** which initiate at the mid-point of the rotor and wind in opposite directions toward each end of the rotor **30**. Each set of these helical threads function in the same manner and are of the same form as threads **20** of the mill of Fig. 1. Rotor **31** is provided with similar helical threads **41** and **42** of opposite hands. Threads **39**, **40**, **41** and **42** serve, when the rotors **30** and **31** are rotated in the direction of the arrows of Fig. 4, to force stock introduced at the mid-point of the rotors toward each end of each of the barrels **26** and **27**.

The bore **28** of barrel **26** is provided with two sets of helical threads **43** and **44**, each set of which function in the same manner and are of the same form as the threads **22** of the mill of Fig. 1. The bore **29** of the barrel **27** is provided with similar sets of helical threads **45** and **46** of opposite hand from the threads **43** and **44**.

The barrels **26** and **27** are provided with a common opening **47** midway between the ends thereof through which stock may be introduced into the mill. A funnel shaped hopper **48** surrounds the opening **47** to facilitate the introduction of the stock. Knives **49**, **50**, **51** and **52**, similar to the knives **24** and **25** of the single end mill of Fig. 1, may be secured to each end of the rotors **30** and **31** as shown in Fig. 4 to cut the discharged stock into pellets. It can be seen that each half of each rotor and the corresponding half of each barrel of the mill of Fig. 3 functions in the same manner as the mill of Fig. 1 to thoroughly mix and work the stock.

The advantages of this double ended, double barrel mill of Fig. 3 over the single ended, single barrel mill of Fig. 1 are increased capacity, balanced thrust on the rotors and easier introduction of the stock into the mill. This last mentioned advantage is due to the fact that the counter-rotating rotors tend to pull the stock into the mill more readily than a single rotating rotor.

From the above description it can be seen that there is provided an improved mill of screw or worm type which will thoroughly mix and work all the stock and will prevent unmixed, unworked lumps of stock from passing through the mill. All the stock goes through the same degree of working and mixing so that the stock when discharged from the mill has been uniformly mixed and worked.

It is to be understood that the above description and accompanying drawings are for the purpose of illustration and not by way of limitation and changes and modifications may be made therein without departing from the spirit and the scope of the invention.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. A mill comprising, a rotor member, a stationary barrel member providing a bore in which the rotor member is adapted to be rotated, means for rotating said rotor member, longitudinally extending helical grooves in one of said members, longitudinally extending grooves in said other member, the grooves in one member decreasing to substantially zero depth at at least one point along its length, the grooves in the other member decreasing to substantially zero depth at at least one point along its length spaced longitudinally from said one point on said one member, said grooves in said rotor member and the grooves in the bore of said barrel member communicating with each other so as to form a continuous passage through the mill through which stock may pass whereby all the stock will pass through the shear plane developed in the clearance between the stationary barrel and the rotating rotor.

2. A mill comprising, a rotor, a stationary barrel providing a bore in which the rotor is adapted to be rotated, means for rotating said rotor, longitudinally extending helical grooves in said rotor, longitudinally extending grooves in the bore of said barrel, the helical grooves in said rotor decreasing to substantially zero depth at at least one point along its length, the grooves in said bore decreasing to substantially zero depth at at least one point along its length spaced from said one point on said rotor, said grooves being co-extensive at least between said one point on said rotor and said one point in said bore of said barrel whereby the grooves together form a continuous passage through the mill through which the stock may pass whereby all the stock must pass through the shear plane developed between the rotating rotor and the stationary barrel.

3. A mill comprising, a rotatable rotor, a barrel surrounding said rotor, means for rotating said rotor, an opening in said barrel spaced from one end thereof for receiving stock, helical grooves in said rotor, helical grooves in the interior surface of said barrel, said grooves in said rotor decreasing to substantially zero depth at at least one point along its length, said helical grooves in said barrel decreasing to substantially zero depth at at least one point along its length spaced longitudinally from said one point on said rotor, said grooves being co-extensive at least between said one point on said rotor and said one point in said barrel whereby the grooves together form a continuous passage through the mill through which the stock may pass whereby all the stock must pass through the shear plane developed between the stationary barrel and the rotating rotor.

4. A mill comprising, a helically threaded rotor, a stationary barrel having a helically threaded bore in which the rotor is adapted to be rotated, the helical threads of said rotor decreasing to substantially zero depth at at least one point along its length, the helical threads of said bore decreasing to substantially zero depth at at least one point along its length longitudinally spaced from said one point on said rotor, said threads being co-extensive at least between said one point on said rotor and said one point in said barrel so that the grooves between said threads on said rotor and in said barrel together form a continuous passage through the mill for the stock and whereby all

the stock will pass through the shear plane, developed between the stationary barrel and the rotating rotor.

5. A mill comprising, a helically threaded rotatable rotor, a stationary barrel providing a bore in which the rotor is adapted to be rotated, means for rotating said rotor, an opening in said barrel spaced from one end thereof for receiving stock, the helical threads of said rotor decreasing to substantially zero depth adjacent said one end of said barrel, grooves in said bore of said barrel extending from said one end of the barrel inwardly a substantial distance past the point of substantial zero depth of said threads whereby stock received through said opening in said barrel will be carried in the grooves formed between the threads of the rotor and be forced into the grooves in the barrel and out the open end thereof and means carried by the end of said rotor for cutting said stock into pellets as it is forced out the open ends of said grooves in said bore of said barrel.

6. A mill comprising, a rotatable rotor, a barrel providing a bore in which the rotor is adapted to be rotated, means for rotating said rotor, an opening in said barrel spaced from one end thereof for receiving stock, helical threads on said rotor and in said bore, said threads on said rotor and in said bore being non-continuous throughout the distance between said opening and said one end of the barrel, portions of said threads on said rotor and in said bore being co-extensive so that the threads on said rotor and in said bore together form a continuous passage for the stock from said opening to said end of the barrel whereby all the stock in passing through the mill is subjected to the shearing action developed between the rotating rotor and the stationary barrel.

7. A mill comprising, a helically threaded rotatable rotor, a stationary barrel providing a bore in which the rotor is adapted to be rotated, means for rotating said rotor, an opening in said barrel spaced from one end thereof for receiving stock, the helical threads of said rotor



decreasing to substantially zero depth adjacent said one end of said barrel, helical grooves in said bore of said barrel extending from said one end of the barrel inwardly a substantial distance past the point of substantial zero depth of said threads whereby stock received through said opening in said barrel will be carried in the helical grooves formed between the threads of the rotor and be forced into the helical grooves in the bore of the barrel and out the end thereof and means carried by the end of said rotor for cutting said stock into pellets as it is forced out the ends of said helical grooves in said bore of said barrel.

8. A mill comprising, a rotor, a stationary barrel providing a bore in which the rotor is adapted to be rotated, means for rotating said rotor, longitudinally extending helical grooves in said rotor, said grooves being non-continuous throughout the length of the rotor, grooves in the bore of said barrel extending between and overlapping said non-continuous sections of said grooves in said rotor so that said grooves in said bore and in said rotor together form a continuous passage through the mill for the stock whereby all the stock in passing through the mill is subjected to the shearing action developed between the rotating rotor and the stationary barrel.

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