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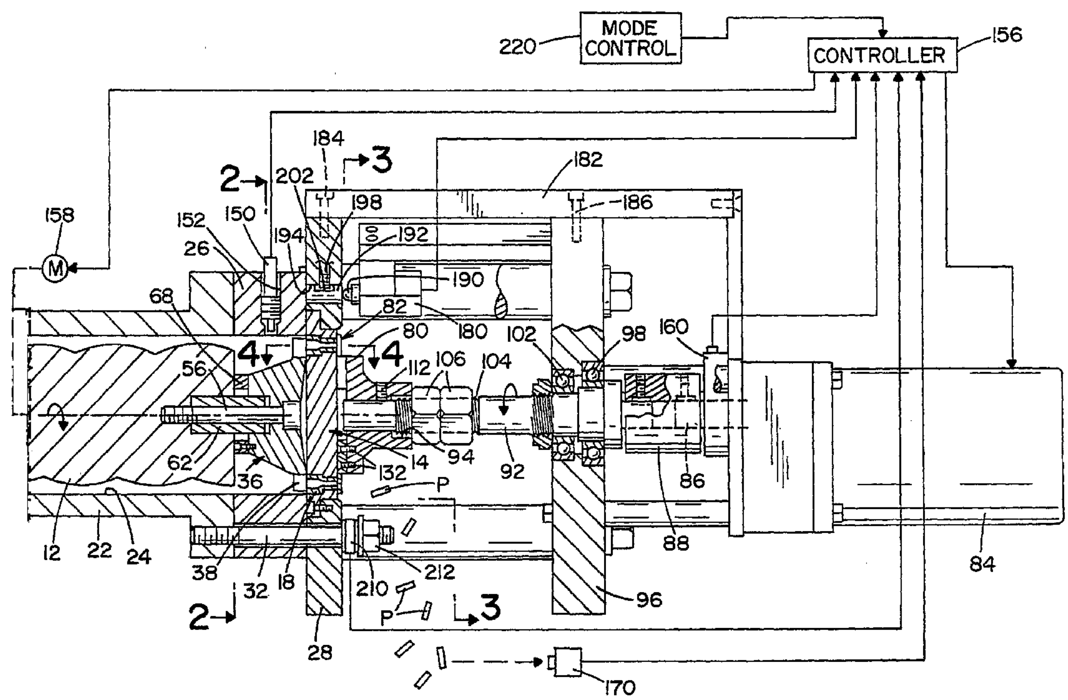

(57) Abstract: A cutting assembly for cutting a material extruded from a die can include a wiper adapted to connect to an auger or other material feeding arrangement, a die holder plate disposed adjacent the wiper, a cutter member disposed downstream from the die holder plate, and an arrangement to control the cutting speed of the cutting member.

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PULSE WAVE MODULATOR CUTTING ASSEMBLY

[0001] This patent application claims priority on U.S. Patent Application Serial No. 11/062,220 filed February 18, 2005; U.S. Patent Application Serial No. 29/242,613 filed November 10, 2005; U.S. Patent Application Serial No. 29/242,779 filed November 15, 2005; and U.S. Patent Application Serial No. 29/242,881 filed November 15, 2005, all of which are incorporated by reference herein in their entirety.

BACKGROUND OF THE INVENTION

[0002] Many types of products are extruded from dies and cut to certain lengths after being extruded through the die. Such products include, but are not limited to, catalyst, human and animal foods, fertilizer, medication, various types of plastic and/or other polymer products, etc. For some types of products (e.g., medication, fertilizer, catalyst, etc.) the cut extruded product should be as uniform as possible. The rate at which a certain product is extruded through a particular die can at least partially depend on a variety of factors such as the wearing of the die components, the wearing of the auger, the density of the product, whether the auger is starved of feed material, plugging of one or more dies inserts, etc. As a result of one or more of these variable factors and/or other factors, the rate at which a particular product extrudes through one or more can periodical vary. This varying of the rate of product extrusion commonly results in the cut extruded product to be non-uniform, thereby resulting in a significant percent of the product to be disposed of.

[0003] Product formed for the medical and catalyst industry are highly sensitive to product uniformity. The uniform size of a catalyst is used to control certain types of chemical reactions. In some types of chemical reactions, a large tolerance as to size variations was acceptable for the catalyst in these chemical reactions. Due to these large acceptable tolerances as to catalyst size, the catalyst could be extruded and cut using conventional technology and about 65-85% of the cut catalyst would be acceptable for use. However, when the tolerances for the size of the catalyst is small when the catalyst is used in other types of chemical reactions, the amount of wasted cut catalyst significantly increases, thereby increasing product costs. In the medical industry, the tolerance for the size of the medical is very low so as to ensure that essentially the same dosage of medicine is present in each pill. As such, most manufacturers of medical use a pill manufacturing process. Pill machines are also used for form some types of catalyst that require a low tolerance to the size of the catalyst. Although the pill manufacturing process produces a large percentage of medication and catalyst having a desired size, the pill manufacturing process is very expensive as compared with most extrusion processed, and also has extremely slow throughputs, resulting in low output over time and significantly increased manufacturing costs. Such high costs are cost prohibitive for many types of products.

[0004] In view of the current state of art, there is a need for a cutting device that can be used to cut extruded product in a more uniform manner.

SUMMARY OF THE INVENTION

[0005] The present invention relates to cutting devices, and more particularly to a cutting device for use with an extruder device, and even more particularly to a cutting assembly to cut materials that have been extruded through one or more dies. In one non-limiting embodiment of the invention, there is provided an improved cutting assembly used to cut materials that have been extruded through one or more dies. The cutting assembly of the present invention is particularly directed the cutting of extruded catalyst; however, the cutting assembly can be used to cut many other types of extruded material.

[0006] The improved cutting assembly is designed to improve the product quality of cut extruded material by cutting the extruded material within low tolerances to a certain specified length. In many types of businesses such as, but not limited to, the pharmaceutical business, the catalyst business, etc., the size of the extruded material must be maintain to comply with stringent criteria. For instance, in the pharmaceutical business, the size of a cut pill affects the dosage of the medication. A pill that has been cut too large or a too small may result in the incorrect dosage being given to the patient. Likewise, in the catalyst industry, the size of the catalyst can affect the rate of reaction that takes place when using the catalyst. An extruded catalyst that is cut too large or too small could adversely affect a chemical reaction that involves the use of the catalyst. The proper cutting of other materials (e.g., foods, fertilizers, etc.) can affect the product quality and/or effectiveness of the cut product. The improved cutting assembly of the present invention is designed to cut an extruded product from a die to form a cut product that more closely matches the desired length of the product, thereby eliminating the need for forming the product by more expensive processes that have lower throughputs. Consequently, products that have historically been formed by pill manufacturing processes (e.g., medication, certain types of catalysts, etc.) can be extruded through one or more dies and cut to a desired length by use of the improved cutting assembly of the present invention. In addition, the improved cutting assembly of the present invention can be used to cut products that are currently extruded through dies and thereby significantly reduce the amount of waste of such extruded product that historically has to be disposed of since the extruded product did not meet the size tolerance parameters of the extruded product. The present invention is thus directed to an extrusion cutting assembly which can increase the quantity of cut product as compared to prior art cutting assemblies.

[0007] In one non-limiting aspect of the present invention, the improved cutting assembly incorporates several new technologies that are used to produce a higher quality product. Each one of these new technologies individually results in increased product quality. In addition, the combination of these new technologies further increases the percentage for producing product having a desired cut length. Prior cutting systems for extruded products commonly produced about 15-35% of the cut product being within 200% of the desired length. The cutting assembly of the present invention results in about 60-99.9% of the cut extruded product being within about 200% of the desired length, typically about 70-99.9% of the cut extruded product being within about 100% of the desired length, more typically about 80-99.9% of the cut extruded product being within about 100% of the desired length, and still more typically about 90-99.9% of the cut extruded product being within about 100% of the desired length. The cutting assembly of the present invention thus produces a higher quality product with significantly less waste. The cutting assembly of the present invention also has higher throughputs without sacrificing product quality.

[0008] In another and/or alternative non-limiting aspect of the present invention, the cutting assembly includes the use of an increased number of wipers positioned closely adjacent to the openings in the die support plate. The wipers are used to direct material to be extruded into the openings for extrusion through the dies positioned in the openings of the dies. The wipers are also and/or alternatively used to reduce or eliminate the amount of space around the openings that can harbor material, thereby reducing or eliminating the amount of material that stagnates or accumulates around the openings. Material that stagnates or accumulates around the openings can become hardened or less formable. This hardened or less formable material will eventually work its way into one of the openings. Due to the hardened or less formable nature of the material, the material can become stuck in the opening, thereby resulting in plugging or clogged the opening. The clogging of the opening reduces the number of dies that are being used to form the extruded product, thereby reducing the amount of product being produced. The clogging of one or more dies also affects the pressure at which the material is extruded through the remaining unclogged openings. For instance, a plate which includes four openings would suddenly encounter a pressure increase of at least about 15-35% in the three unclogged openings when one of the openings becomes clogged. The increased pressure exerted on the extruded material results in the material being forced through the openings at an increased rate, thereby resulting in the lengths of the cut catalysts being increased when the cutting blade is running at a constant speed. The increased length of the cut product can result in an unacceptable product due to the unacceptably long product length, thus reducing the yield of acceptable product. The increased pressure on the material can also adversely affect the extruded material (e.g., adversely breaking down chemical bonds or structures, unacceptably increasing the heat applied to the material thereby resulting in adverse chemical reactions or structural formations, etc.). Such adverse affects on the extruded material can result in the material being unacceptable for its end use, even if the cut length is within an acceptable range. In one non-limiting embodiment of the invention, the wiper blades of the improved cutting assembly are designed to reduce or eliminate the space about the openings that can harbor material to be extruded, thereby reducing or eliminating the incidence of one or more of the openings becoming partially or fully plugged or clogged during an extruding process. In one non-limiting aspect of this embodiment, the wiper blades result in at least about a 20% reduction in the space about the openings that can harbor material to be extruded. In another non-limiting aspect of this embodiment, the wiper blades result in at least about a 50% reduction in the space about the openings that can harbor material to be extruded. In still another non-limiting aspect of this embodiment, the wiper blades result in at least about a 75% reduction in the space about the openings that can harbor material to be extruded. In another and/or alternative non-limiting embodiment of the invention, the wiper blades of the improved cutting assembly reduce the pressure variations of the material being directed into the openings of the die holder. Typically, an auger is used to direct the material to be extruded toward the openings in the die holder plate. Most of these augers have a single flight configuration; however, dual flight configurations can be used. As the auger is rotated, the material to be extruded is moved toward the openings in the die holder plate. An opening in the die holder plate that is positioned closest to the face of the blade of the auger at a certain time is exposed to a higher pressure by the material than another opening on the die holder plate which is positioned at a farther distance from the blade face of the auger. As a result, when the auger is rotated during operation of the extruder, the pressure being applied to the extruded material at a particular opening increased as the face of the blade approaches a particular opening in the die holder plate and then decreases after the face of the blade passes the opening and moves to another opening as the auger rotates. The increasing and decreasing pressure being exerted on the material through the opening results in the material being accelerated and decelerated through the openings as the auger rotates. The increased speed at which the material passes through an opening results in an increased length of the material being cut when the cutter blade is rotated at a constant speed. The reduced speed at which material passes through an opening results in a reduced length of material being cut when the cutter blade is rotated at a constant speed. As a result, the cut material constantly varies in length due in part to the rotation of the auger feeding the material to be extruded through the die plates. The use of multiple wiper blades positioned between the end of the auger and the openings in the die holder plate results in a reduction of the pressure amplitude differential between a high and low pressure situation, thereby resulting in a more constant pressure being applied to the material directed into the plurality of openings in the die holder plate. As a result, the length of the cut material is more uniform due to the relatively constant pressure being applied on the material at all the openings in the die holder plate, thereby resulting in a higher percentage of acceptable product being produced. In one non-limiting aspect of this embodiment, a plurality of wiper blades are used in the improved cutting assembly to reduce or eliminate the pressure amplitude differential between a high and low pressure situation during the extrusion of material through one or more die plates. In another non-limiting design, the number of wiper blades used in the improved cutting assembly is at least one-forth the number of openings in the die holder plate. In still another non-limiting design, the number of wiper blades used in the improved cutting assembly is at least one-half the number of openings in the die holder plate. In yet another non-limiting design, the number of wiper blades used in the improved cutting assembly is at least three-quarters the number of openings in the die holder plate. In still yet another non-limiting design, the number of wiper blades used in the improved cutting assembly is equal to or greater than the number of openings in the die holder plate. In a further non-limiting design, the number of wiper blades used in the improved cutting assembly is at least 1.5 times the number of openings in the die holder plate. In still a further non-limiting design, the number of wiper blades used in the improved cutting assembly is at least 2 times the number of openings in the die holder plate.

[0009] In still another and/or alternative non-limiting aspect of the present invention, the cutting assembly includes wiper blades that are connected to the end of the auger and are positioned closely adjacent to the openings in the die holder plate so as to reduce the amount of area about an opening which can harbor stagnant material. In one non-limiting aspect of this embodiment, at least a portion of at least one wiper blade is positioned from the plane of the die opening and at a distance of less than about 0.5 inches from the opening in the die plates. In another non-limiting aspect of this embodiment, at least a portion of at least one wiper blade is positioned from the plane of the die opening and at a distance of less than about 0.25 inches from the opening in the die plates. In still another non-limiting aspect of this embodiment, at least a portion of at least one wiper blade is positioned from the plane of the die opening and at a distance of about 0-0.1 inches from the opening in the die plates. In yet another non-limiting aspect of this embodiment, at least a portion of at least one wiper blade is positioned from the plane of the die opening and at a distance of about 0-0.065 inches from the opening in the die plates.

[0010] In yet another and/or alternative non-limiting aspect of the present invention, the cutting assembly includes wiper blades that are sized so that they are at least as large as the openings in the die holder plate so as to facilitate in directing material into the openings. The size of the one or more wiper blades can be used to reduce the amount of dead area about the die opening when a particular wiper blade passes by and over the die opening, thereby reducing the amount of stagnant material which can become entrapped or stagnant about the die opening or within the wiper area. It has been found that by properly designing the wiper blades, the amount of cut product that is within size tolerance range for a particular product can be improves by up to 25% or more. This significant improvement in the amount of acceptable product reduces the amount of product that must be disposed of due to the fact that the cut length is too long or short. In one non-limiting aspect of this embodiment, the size of at least one of the wiper blades are up to about 5% larger than the diameter of the openings in the die holder plate. In another non-limiting aspect of this embodiment, the size of at least one of the wiper blades are up to about 10% larger than the diameter of the openings in the die holder plate. In still another non-limiting aspect of this embodiment, the size of at least one of the wiper blades are up to about 20% larger than the diameter of the openings in the die holder plate. In still another non-limiting aspect of this embodiment, the size of at least one of the wiper blades are up to about 30% larger than the diameter of the openings in the die holder plate.

[0011] In still yet another and/or alternative non-limiting embodiment of the invention, the plurality of wiper blades are substantially equally spaced apart so as to create a more uniform pressure at the die opening, thereby resulting in a more uniform length of product that is cut by the cutting assembly during the extrusion process.

[0012] In still yet another and/or alternative non-limiting aspect of the present invention, the cutting assembly includes wiper blades that are substantially the same shape and size so as to create a more uniform pressure at the die opening, thereby resulting in a more uniform length of product that is cut by the cutting assembly during the extrusion process.

[0013] In a further and/or alternative non-limiting aspect of the present invention, the cutting assembly includes wiper blades that have an angle that is used to facilitate in pushing the material into the openings in the die plate. The angle is selected to facilitate movement of the material into the die openings without cutting or substantially cutting the material. In essence, the angled wiper blade smears the material to be extruded into the opening in the die plate as the wiper blade passes over the die plate opening. The selection of the wiper blade angle can also or alternatively be used control the pressure of the material being forced through the die plate openings. As such, the angled wiper blade reduces the occurrence of stagnated material about the die plate openings and can facilitate in flow rates of the material through the die plate openings. In one non-limiting aspect of this embodiment, the angle on at least a portion of one or more wiper blades is about 1-89°. In another non-limiting aspect of this embodiment, the angle on at least a portion of one or more wiper blades is about 10-70°. In still another non-limiting aspect of this embodiment, the angle on at least a portion of one or more wiper blades is about 15-60°. In yet another non-limiting aspect of this embodiment, the angle on at least a portion of one or more wiper blades is about 20-45°. In still yet another non-limiting aspect of this embodiment, the angle on at least a portion of one or more wiper blades is about 25-35°.

[0014] In still a further and/or alternative non-limiting aspect of the present invention, a single uninterrupted flight auger is used to move the material to be extruded toward the wiper blades and through the die plate openings. The single uninterrupted flight auger creates a more uniform profile on the material being fed to the die plate as compared to interrupted flight augers. The more uniform pressure profile at the die opening results in a more uniform length of product that is cut by the cutting assembly during the extrusion process.

[0015] In still a further and/or alternative non-limiting aspect of the present invention, the improved cutting assembly includes an improved control arrangement which can vary the cutting blade speed to better account for the pressure differentials applied to the material being extruded through a die in a particular opening of the die holder plate. When the pressure on the extruded material increases, the material travels at a faster rate through the die. Conversely, when the pressure on the extruded material reduces, the extruded material passes at a slower rate through the die. By detecting the pressure of the material as it enters into one or more openings in the die holder plate, it can be determined whether the material is accelerating, decelerating, or maintaining a constant velocity through the die within the die holder plate. If it is detected that the pressure has decreased, the speed of the blade can be accordingly decreased. If it is found that the pressure of the material has increased, the speed of the blade can be accordingly increased. Furthermore, if it is found that the pressure is constant, the speed of the blade can be maintained as constant. As a result, the control of the blade speed used to cut the material that has been extruded through one or more dies can be controlled so as to maintain a desired cut length of the cut extruded material. The rate of increase or decrease of the blade speed can be linear or non-linear. The change in blade speed can be delayed to account for the time that the material enters into the opening in the die holder plate and passes through the die prior to being cut by the blade; however, this is not required. In one non-limiting embodiment of the invention, an electronic control system is used to control the rate at which the cutting blade cuts the material being extruded from one or more dies. In one non-limiting aspect of this embodiment, a pulse width modulator control system is used to control the rate at which the cutting blade cuts the material being extruded from one or more dies. As can be appreciated, other control systems can be used. In another and/or alternative non-limiting embodiment of the invention, the control of the blade speed with respect to the detected pressure in one or more of the die plate openings can used to adjust the cutting blade speed to account for abnormalities in the feed rate of the material being extruded. For instance, when one or more of the openings for the extruded material is plugged or clogged, thereby resulting in a significant increase in pressure on the extruded material through the remaining unclogged openings, the velocity of the cutting blade can be increased to account for the increased speed at which the material is extruded through the remaining unclogged openings.

[0016] In still another and/or alternative non-limiting embodiment of the invention, the control of the blade speed with respect to the detected pressure in one or more of the openings in the die holder plate can used to adjust the cutting blade speed to account for abnormalities in the feed rate of the material being extruded. For instance, when one or more of the openings for the extruded material is plugged or clogged, such clogging of the die plate opening results in an increase in pressure on the extruded material prior to the material moving through the remaining unclogged openings. A clogged die opening will result in significant pressure drop. This pressure drop reduction can be used to adjust the speed of the cutting blade to at least in part account for an increase in pressure of the material through the unplugged die openings. Alternative or additionally, a pressure sensor in one or more of the unplugged openings will indicate a pressure increase when one or more of the die openings becomes plugged. Consequently, the one or more pressure signals can be used to adjust the speed of the cutting blade to at least in part account for an increase in pressure of the material through the unplugged die openings and/or a decrease in pressure through one or more plugged die openings. As such, the velocity of the cutting blade can be increased to account for the increased speed at which the material is extruded through the remaining unclogged openings. In another situation, with the extruder is starved of feeder material, the pressure on the extruded material can decrease on the extruded material prior to the material moving through the remaining unclogged openings. As such, the velocity of the cutting blade can be decreased to account for the decreased speed at which the material is extruded through the openings in the die plate. In one non-limiting embodiment of the invention, the one or more pressure sensors generate a signal that can be used to activate an alarm to indicated that the detected pressure is below and/or above a desired value. This alarm can be used to detect and/or notify an operator of clogged die openings, worn components (e.g., worn auger, worn die plate, worn die inserts, worn die pins, etc.), insufficient feeding of material to be extruded, etc. In another and/or alternative embodiment of the invention, the improved cutting assembly can include a storage system that stores date regarding the detected pressures over a period of time. This data can be used to facilitate in determine whether one or more components of the extruder and/or cutting assembly were operating properly during an extrusion process. The data can be tagged to a time and/or date period; however, this is not required. This data can be designed to be accessed at real time and/or in other manners. The collected data can be used to activate one or more alarms to indicate a existing or potential problem with one or more components of the extruder and/or cutting assembly; however, this is not required. The collected data can be used to activate one or more alarms to indicate that a component change out is due for one or more components of the extruder and/or cutting assembly; however, this is not required. The collected can be use to profile the operation of one or more components of the extruder and/or cutting assembly; however, this is not required.

[0017] In yet another and/or alternative non-limiting embodiment of the invention, the control of the blade speed with respect to the detected pressure spaced from the openings in the die holder plate can used to adjust the cutting blade speed to account for abnormalities in the feed rate of the material being extruded. For instance, when one or more of the openings for the extruded material is plugged or clogged, such clogging of the die plate opening results in an increase in pressure on the extruded material prior to the material moving through the remaining unclogged openings. As such, the velocity of the cutting blade can be increased to account for the increased speed at which the material is extruded through the remaining unclogged openings. In another situation, with the extruder is starved of feeder material, the pressure on the extruded material can decrease on the extruded material prior to the material moving through the remaining unclogged openings. As such, the velocity of the cutting blade can be decreased to account for the decreased speed at which the material is extruded through the openings in the die plate. The speed at which a feed material is moved toward one or more die openings can vary depending on the type of material and/or the type of auger or other type of feeding device. Even when wiper blades are used to decrease the range of pressure fluctuations as the material is being fed through one or more die openings, the changes in pressure being applied to the material being extruded result in an increased and a decreased velocities through the dies. In addition, the rate at which material is fed into a feeder (e.g. auger) can vary, thereby resulting in variable amounts of material being fed to the one or more openings in the die holder plate. Reduced amounts of material in the feeder can result in reduced pressure on the material that is ultimately fed through the one or more openings in the die holder plate. Increased amounts of material in the feeder can result in increased pressure on the material that is ultimately fed through the one or more openings in the die holder plate. The detection of these pressure fluctuations can be used to increase and/or decrease the cutting blade speed to obtain cut extruded product having a more consistent cut length. As such, by detecting these increases and decreases in pressure, the speed of the cutting blade can be adjusted to obtain more cut product having a length within an acceptable range. By detecting the pressure being exerted on the material that is being directed into the one or more openings in the die plate, the cutting blade speed can be increased to account for an increased velocity of the material passing through the dies, or decreased to account for a decreased velocity of the material passing through the dies, thereby maintaining the desired cut length of the material being cut by the cutting blades. The detected pressure can be in a single or multiple locations that are spaced from the die openings (e.g., at the begging of the die openings, in the region of the wiper blades, along the length of the auger, etc.). Consequently, the one or more pressure signals can be used to adjust the speed of the cutting blade to at least in part account for an increase and/ir decrease in pressure of the material that is to move through the one or more die openings. As such, the velocity of the cutting blade can be increased to account for the increased speed at which the material is anticipated to be extruded through the die openings. In one non-limiting embodiment of the invention, the one or more pressure sensors generate a signal that can be used to activate an alarm to indicated that the detected pressure is below and/or above a desired value. This alarm can be used to detect and/or notify an operator of clogged die openings, worn components (e.g., worn auger, worn die plate, worn die inserts, worn die pins, worn wiper blades, etc.), insufficient feeding of material to be extruded, etc. In another and/or alternative embodiment of the invention, the one or more pressure sensors that are spaced from the die plate openings can be used in conjunction with one or more pressure signals that are portioned in at least a portion of the die openings to at least partially control the speed of the cutting blade and/or to activate one or more alarms when the detected pressure is undesired. In one non-limiting embodiment of the invention, the one or more pressure sensors generate a signal that can be used to activate an alarm to indicated that the detected pressure is below and/or above a desired value. This alarm can be used to detect and/or notify an operator of clogged die openings, worn components (e.g., worn auger, worn die plate, worn die inserts, worn die pins, etc.), insufficient feeding of material to be extruded, etc. In still another and/or alternative embodiment of the invention, the improved cutting assembly can include a storage system that stores date regarding the detected pressures over a period of time. This data can be used to facilitate in determine whether one or more components of the extruder and/or cutting assembly were operating properly during an extrusion process. The data can be tagged to a time and/or date period; however, this is not required. This data can be designed to be accessed at real time and/or in other manners. The collected data can be used to activate one or more alarms to indicate a existing or potential problem with one or more components of the extruder and/or cutting assembly; however, this is not required. The collected data can be used to activate one or more alarms to indicate that a component change out is due for one or more components of the extruder and/or cutting assembly; however, this is not required. The collected can be use to profile the operation of one or more components of the extruder and/or cutting assembly; however, this is not required.

[0018] In still yet another and/or alternative non-limiting embodiment of the invention, the improved cutting assembly includes one or more sensors other than a pressure sensor that us used to affect the cutting speed of the cutting blade and/or activate one or more alarms. Such other sensors can include, but are not limited to, temperature sensors, flow sensors, compositions sensors, auger rotation speed, blade cutter arrangement speed, die opening plug detectors, product quality detectors, die plate pressure detectors, etc. These one or more sensors can be located in one or more die plate openings, positioned on and/or located in the die plate, and/or spaced from one or more die plate openings. The data from one or more of these sensors can be recorded; however, this is not required. The data can be tagged to a time and/or date period; however, this is not required. The data from one or more of the sensors can also or alternatively be used to control the operation of one or more components of the cutting assembly (e.g., cutting blade rotation speed, etc.) and/or one or more components of the extruder (e.g., auger rotation speed, material feed rate into auger, etc.). The collected data can be also or alternatively be used to activate one or more alarms to indicate that a component change out is due for one or more components of the extruder, and/or the cutting assembly and/or one or more components of the extruder are not working properly; however, this is not required. The collected can be use to profile the operation of one or more components of the extruder and/or cutting assembly; however, this is not required. In another and/or alternative embodiment of the invention, additional data can be used by the cutting assembly to monitor and/or control one or more components of the extruder and/or cutting assembly. Such data can include, but is not limited to, die plate size, die plate opening configuration, die plate opening size, material of the die plate, thickness of the die plate, die insert size, die insert shape, die insert thickness, die insert material, type of insert pins, shape of insert pins, material of pins, type of auger, material of auger, type of feed material, type of cutting blades, number of cutting blades, cutting blade material, number of wiper blades, type of wiper blades, spacing of wiper blades from die plate, wiper blade material, etc.

[0019] In a further and/or alternative non-limiting embodiment of the invention, the improved cutting assembly includes a cutting blade arrangement to improve the quality and cut length consistency of the cut extruded product. In one non-limiting embodiment of the invention, the cutting blade arrangement includes a plurality of cutting blades that are spaced at substantially equal distances from one another and/or spaced at substantially equal angular distances from one another. For instance, when the cutting blade arrangement is a generally circular disc-shaped, a two blade system would be about 180° from one another, a three blade system would be about 120° from one another, a four blade system would be about 90° from one another, a five blade system would be about 72° from one another, a six blade system would be about 60° from one another, an eight blade system would be about 45° from one another, a nine blade system would be about 40° from one another, a ten blade system would be about 36° from one another, a twelve blade system would be about 30° from one another, a fifteen blade system would be about 24° from one another, a sixteen blade system would be about 22.5° from one another, an eighteen blade system would be about 20° from one another, a twenty blade system would be about 18° from one another, a twenty-four blade system would be about 15° from one another, etc. As can be appreciated, the cutting blade arrangement can have a shape other than a generally circular disc-shaped. In another and/or alternative embodiment of the invention, one or more of the cutting blades has a novel cutting profile to facilitate in the cutting of the extruded material. In one non-limiting aspect of this embodiment, one or more cutting blades includes an angular primary cutting surface. The primary cutting surface is used as the principal cutting surface of the blade. The slope angle of the primary cutting surface is used to effectively cut the extruded product. In one non-limiting design, the slope angle of the primary cutting surface is generally about 20-85°. In another non-limiting design, the slope angle of the primary cutting surface is generally about 25-60°. In still another non-limiting design, the slope angle of the primary cutting surface is generally about 20-35°. In yet another non-limiting design, the slope angle of the primary cutting surface is generally about 25-35°. In another and/or alternative non-limiting aspect of this embodiment, one or more cutting blades includes a rake surface that has a rake angle. The rake surface is positioned on the same side of the one or more cutting blades as the primary cutting surface and is position next to the primary cutting surface. Typically, the primary cutting surface transitions into the rake surface; however, this is not require. The rake angle is less than the slope angle of the primary cutting surface. The rake angle is used in part to create a trajectory of the material after it has been cut by the primary surface. This trajectory of the material is used to more the material off of the cutting blade and/or to through the cut material to a desired location. In one non-limiting design, the slope angle of the rake surface is generally about 1-84°. In another non-limiting design, the slope angle of the rake surface is generally about 5-75°. In still another non-limiting design, the slope angle of the rake surface is generally about 10-60°. In yet another non-limiting design, the slope angle of the rake surface is generally about 10-45°. In still yet another non-limiting design, the slope angle of the rake surface is generally about 15-30°. In further non-limiting design, the slope angle of the rake surface is generally about 15-25°. In still another and/or alternative non-limiting aspect of this embodiment, one or more cutting blades includes a clearance surface that has a clearance angle. The clearance surface is positioned on the opposite side of the one or more cutting blades as the primary cutting surface, and the rake surface when used. The clearance surface is positioned is also position at about the same level on the blade as the primary cutting surface and/or rake surface, when the rake surface is used. The clearance surface is designed to facilitate in enable the cutting blade to clear the continuously extruded product. Once the primary cutting surface has cut a portion of the extruded product, more extruded product moves out from the die plate openings. This front end of the extruded material can cause interference with the cutting blade, and thereby cause improper rotation speeds of the cutting blade arrangement. The clearance angle on the blade is selected so as to enable the back side of the cutting blade to easily move past the front end of the extrude product and thereby facilitate in the proper operation of the cutting blade arrangement and proper and consistent rotation speeds of the cutting blade arrangement. In one non-limiting design, the slope angle of the clearance surface is generally about 1-65°. In another non-limiting design, the slope angle of the clearance surface is generally about 3-50°. In still another non-limiting design, the slope angle of the clearance surface is generally about 3-40°. In yet another non-limiting design, the slope angle of the clearance surface is generally about 5-30°. In still yet another non-limiting design, the slope angle of the clearance surface is generally about 5-20°. In a further non-limiting design, the slope angle of the clearance surface is generally about 8-15°.

[0020] In a further and/or alternative non-limiting embodiment of the invention, the improved cutting assembly can include one or more operational modes. In one non-limiting embodiment of the invention, one mode of the cutting assembly can be a manual mode wherein the speed of the cutting blade is set and maintained at a substantially constant speed throughout an extrusion process. In another and/or alternative non-limiting embodiment of the invention, one more of the improved cutting assembly can include an automatic mode wherein the speed of the cutting blade is adjusted based upon one or more set and/or detected parameters (e.g., die plate temperature, auger temperature, material to be extruded temperature, material to be extruded flow rate, material to be extruded composition, material to be extruded density, time period required for material to move through die inserts, auger rotation speed, blade cutter arrangement speed, die opening plug detection, product quality detection, die plate pressure detection, pressure in one or more die plate openings, temperature in one or more die plate openings, time of use for die inserts, time of use for die plate, time of use for die pins, time of use for auger, time of use for liner, type of liner, material of liner, shape of liner, die plate size, die plate opening configuration, die plate opening size, material of the die plate, thickness of the die plate, die insert size, die insert shape, die insert thickness, die insert material, type of insert pins, shape of insert pins, material of pins, type of auger, material of auger, type of feed material, type of cutting blades, number of cutting blades, cutting blade material, number of wiper blades, type of wiper blades, spacing of wiper blades from die plate, wiper blade material, etc.) so as to obtain the desired cut material length and/or product quality of the extruded and cut material. In one non-limiting aspect of this embodiment, the pressure of the material prior to and/or as the material is inserted through one or more die openings is detected in one or more of the die openings and/or regions about one or more for the die openings so as to at least partially control the rotation speed of the cutting blade arrangement on the cutting assembly. In another and/or alternative non-limiting aspect of this embodiment, the temperature of the material prior to and/or as the material is inserted through one or more die openings is detected in one or more of the die openings and/or regions about one or more for the die openings so as to at least partially control the rotation speed of the cutting blade arrangement on the cutting assembly. In still another and/or alternative one non-limiting aspect of this embodiment, the velocity of the material prior to and/or as the material is inserted through one or more die openings is detected in one or more of the die openings and/or regions about one or more for the die openings so as to at least partially control the rotation speed of the cutting blade arrangement on the cutting assembly. In yet another and/or alternative one non-limiting aspect of this embodiment, the average cut product length of the extruded and cut material is actually detected and/or calculated from one or more of the die openings so as to at least partially control the rotation speed of the cutting blade arrangement on the cutting assembly. In still yet another and/or alternative one non-limiting aspect of this embodiment, the improved cutting assembly can include one or more adjustable parameters to adjust the length of the extruded material being cut so as to obtain a desired length of the cut material, calibrate the pressure so that the speed control for the cutting blade is properly adjusted based upon a particular detected pressure, and/or adjust the delay so as to delay the adjustment of the speed of the cutting blade to account for the time period in which the material travels into and through a die, etc.

[0021] In still a further and/or alternative non-limiting embodiment of the invention, the improved cutting assembly can include one or more detectors (camera, light sensor, radio frequency sensor, sound wave sensor, etc.) to monitor the length of the extruded material prior to, during, and/or after the cutting process. This monitored information can be used to provide data on the quality of the material being cut, the percentage of the material being cut that is within an acceptable length, and/or to control the speed of the cutting blade to better obtain a desired cut length of the material. As can be appreciated, the detection of the length of the cut material can be monitored at the location of the cutting blade and/or at some period after the material has been cut (e.g. when the cut material is being conveyed to a drying location, etc.). In one non-limiting embodiment of the invention, a video monitor or other device can be used to monitor the material being cut and/or conveyed and a software program or other type of statistical device can be used to determine the length of the cut product and send such information to the controller to be used to adjust the speed of the blade based upon the determined length for the cut product and/or provide quality control data regarding the cut product. In another and/or alternative non-limiting embodiment of the invention, a closed loop system could be used to further simplify the control system (e.g., reduce the number of control switches an operator uses) and/or facilitate in obtaining the desired product quality.

[0022] In yet a further and/or alternative non-limiting embodiment of the invention, the improved cutting assembly can include various features used to deactivate the cutting blade especially when one or more dies are being replaced. It is not uncommon that the die plate, die insert, pin, auger blade, etc. has to be periodically services and/or replaced after a run. A run may be as short as a few minutes or as long as several days or months. When one or more components are removed and/or serviced, it is important not to inadvertently activate the cutting blades during such operation, wherein such operation could result in the damage to the blades. The improved cutting assembly of the present invention can include one or more detectors, switches, etc. which fully or partially deactivates one or more components of the cutting assembly during repair and/or maintenance of the cutting assembly and/or one or more components of the extruder so as to reduce or prevent damage to one or more components of the cutting assembly.

[0023] In still yet a further and/or alternative non-limiting embodiment of the invention, the improved cutting assembly can be ergonomically designed so as to facilitate in the operation of the cutting assembly and/or to facilitate in the repair and maintenance of the cutting assembly. In one non-limiting embodiment of the invention, the cutting assembly allows the operator to easily access various connectors, bolts, switches, etc. which are required for periodic operation and/or maintenance of the cutting assembly. As a result of this ergonomic design, the need for special tools is reduced or eliminated and/or the operation and/or maintenance of the cutting assembly is simplified, thereby reducing the time and/or cost of maintenance and repair.

[0024] One non-limiting object of the present invention is the provision of a method and process for forming more uniform cut lengths of an extruded product.

[0025] Another and/or alternative non-limiting object of the present invention is the provision of a method and process for a cutting assembly that can be used to improve the forming more uniform cut lengths of an extruded product.

[0026] Still another and/or alternative non-limiting object of the present invention is the provision of a method and process for a cutting assembly that can vary the speed of the cutting blade based on or more detected parameters and/or set variables to improve the forming more uniform cut lengths of an extruded product.

[0027] Yet another and/or alternative non-limiting object of the present invention is the provision of a method and process for a cutting assembly that includes a wiper blade assembly to inhibit or prevent plugging or clogging of one or more die openings.

[0028] Still yet another and/or alternative non-limiting object of the present invention is the provision of a method and process for a cutting assembly that includes angular wiper blades to inhibit or prevent plugging or clogging of one or more die openings.

[0029] A further and/or alternative non-limiting object of the present invention is the provision of a method and process for a cutting assembly that includes unique shaped and angular cutting blades to improve the forming more uniform cut lengths of an extruded product.

[0030] Still a further and/or alternative non-limiting object of the present invention is the provision of a method and process for a cutting assembly that includes improved auger blade to improve the forming more uniform cut lengths of an extruded product.

[0031] These and other advantages will become apparent to those skilled in the art upon the reading and following of this description taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

[0032] Reference may now be made to the drawings, which illustrate various embodiments that the invention may take in physical form and in certain parts and arrangements of parts wherein:

[0033] FIGURE 1 is a side elevation view, partially in cross section, of a cutting assembly according to an embodiment of the present invention.

[0034] FIGURE 2 is a cross-sectional view taken along line 2-2 of FIGURE 1.

[0035] FIGURE 3 is a cross-sectional view taken along line 3-3 of FIGURE 1.

[0036] FIGURE 4 is a cross-sectional view taken along line 4-4 of FIGURE 1.

[0037] FIGURE 5 is a perspective view of a wiper of the cutting assembly of FIGURE 1.

[0038] FIGURE 6 is a side elevation view, partially in cross section, of the wiper of FIGURE 5.

[0039] FIGURE 7 is an end view of the wiper of FIGURE 5.

[0040] FIGURE 8 is a cross-sectional view taken along line 8-8 of FIGURE 6.

[0041] FIGURE 9 is an end view of an alternative embodiment of a wiper for use with the cutting assembly of FIGURE 1.

[0042] FIGURE 10 is a side elevation view, partially in cross section, of the wiper of FIGURE 9.

[0043] FIGURE 11 is an end view, opposite the end shown in FIGURE 9, of the wiper of FIGURE 9.

[0044] FIGURE 12 is a cross-sectional view taken along line 12-12 of FIGURE 10.

[0045] FIGURE 13 is a side elevation view, partially in cross section, of a cutter head for use with the cutting assembly of FIGURE 1.

[0046] FIGURE 14 is a perspective view of a cutter knife that connects to the cutter head of FIGURE 13.

[0047] FIGURE 15 is a front elevation view of the cutter knife of FIGURE 14.

[0048] FIGURE 16 is a side elevation view, partially in cross section, of the cutter knife of FIGURE 14.

[0049] FIGURE 17 is a rear elevation view of the cutter knife of FIGURE 14.

[0050] FIGURE 18 is a cross-sectional view taken along line 18-18 in FIGURE 16.

[0051] FIGURE 19 is an elevation view of a non-limiting single continuous flight extruder feed screw that can be used in the present invention.

[0052] FIGURE 20 is an end view of an extruder feed screw of FIGURE 19.

[0053] FIGURE 21 is a cross-sectional view taken along line 21-21 of FIGURE 19.

[0054] FIGURE 22 is an elevation view of another non-limiting single continuous flight extruder feed screw that can be used in the present.

[0055] FIGURE 23 is an end view of an extruder feed of FIGURE 22.

[0056] FIGURE 24 is a cross-sectional view taken along line 41-24 of FIGURE 22.

[0057] FIGURE 25 is an elevation view of a non-limiting two blade wiper blade that can be used in the present invention.

[0058] FIGURE 26 is a top plan view of a wiper blade shown in FIGURE 25.

[0059] FIGURE 27 is a side view of a wipe blade shown in FIGURE 25.

[0060] FIGURE 28 is an end view of a wiper blade shown in FIGURE 25.

[0061] FIGURE 29 is a bottom plan view of a wiper blade shown in FIGURE 25.

[0062] FIGURE 30 is an elevation view of another non-limiting two blade wiper blade that can be used in the present invention.

[0063] FIGURE 31 is a top plan view of the wiper blade shown in FIGURE 30.

[0064] FIGURE 32 is a side view of the wipe blade shown in FIGURE 30.

[0065] FIGURE 33 is an end view of the wiper blade shown in FIGURE 30.

[0066] FIGURE 34 is a bottom plan view of the wiper blade shown in FIGURE 30.

DETAILED DESCRIPTION OF THE INVENTION

[0067] Referring now to the drawings wherein the showing is for the purpose of illustrating preferred embodiments of the invention only and not for the purpose of limiting the same, FIGURE 1 illustrates one non-limiting configuration of an auger 12 moves material to be extruded toward a die plate 14 having a plurality of die openings 16 that receive dies 18. The material will become an extruded product such as, but not limited to, a catalyst. As can be appreciated, the present invention can be used for may types of products other than catalyst. The auger 12 can be a standard auger such as a standard single flight configuration or a dual flight configuration. Auger 12 can have a unique single continuous single flight configuration such as, but not limited to, the augers illustrated in FIGURES 19-24. The continuous single flight auger helps to reduce pressure variations as the material moves into the die openings, The auger 12 is housed in an auger housing 22 that defines a cylindrical opening 24 through which the material to be extruded travels. As can be appreciated, other housing shapes can be used. The die plate

14, in the depicted embodiment, is a circular plate having a plurality of die openings 16 formed through the plate. As can be appreciated, the die plate need not be circular. The die openings 18 in the die plate depicted in the figures are shown in only one configuration for the sake of clarity only. The die openings 18 can take numerous configurations.

[0068] An annular spacer 26 is attached to an end of the auger housing 22 and an annular die holder 28 attaches to the annular spacer 26 via fasteners 32. The annular spacer 26 and the annular die holder 28 can house some of the components of the cutting assembly. These components will be described in more detail below.

[0069] A wiper 36 attaches to an upstream end face of the auger 12. The wiper includes a plurality of wiper blades 38 that encourage the material to be extruded into the dies 18. With reference to FIGURES 2 and 4, the wiper blades 38 reduce or eliminate space around the die openings 16. The aforementioned space can harbor material that can stagnate or accumulate around the die openings. The wiper blades 38 can also reduce pressure variations of the material to be extruded as it enters into the dies, as compared to systems that do not employ such a wiper.

[0070] With reference to FIGURE 5, the wiper 36 has a generally frustoconical body 40 that is concentric about a rotational axis 42. The wiper blades 38 extend radially outward from an upstream end of the body 40. With reference to FIGURE 8, each wiper blade 38 includes an inclined leading edge 44 and a trailing edge 46, the edges being defined by the direction that the wiper rotates. With reference to FIGURE 4, the leading edge 44 is inclined to encourage the movement of material into the die 18. Each wiper blade 38 also includes an outer axial edge 48 that contacts or is positioned closely adjacent an upstream face of the die plate 14. The outer axial edge 48, in the depicted embodiment, is also at least generally parallel to the upstream face of the die plate 14. This configuration reduces the likelihood that a material clogging the dies 18 because the wiper blades 38 remove any hardened material from around the die openings 16. The shape of the wiper blades facilitates the moving of the material to be extruded into the die openings and/or helps to reduce pressure variations as the material moves into the die openings. Non-limiting examples of other wiper blade shapes that can be used in the present invention are illustrated in FIGURES 25-34. Although FIGURE 25-34 only illustrate a two blade wiper blade system, the configuration of these two blades can be used on a wiper arrangement having more than two blades. As illustrated in FIGURES 2, 4 and 25-34, the wiper blades are typically spaced at equal distances apart from one another; however, this is not required. As best illustrated in

FIGURES 25-34, the wiper blades included angled faces that facilitate in the movement of the material to be extruded into the die openings.

[0071] As mentioned above, the wiper 36 attaches to an end face of the auger 12. With reference back to FIGURE 6, the wiper 36 includes a slightly bowl-shaped downstream surface 52 and a central opening 54 beginning in the downstream surface 52 for receiving a fastener 56 (FIGURE 1). The fastener 56 is countersunk into the body 40 of the wiper 36 to sit flush with the downstream face 52. The wiper 36 also includes a front drive block opening 58 aligned along the central axis 42. The drive block opening is polygonal in cross section, which in this embodiment is substantially square. The drive block opening 58 receives a drive block 62 (FIGURE 1) that is also received in a corresponding opening provided in the auger 12. The drive block 62 includes a threaded central opening for receiving the fastener 56, and the auger 12 also includes a corresponding threaded opening for receiving the fastener 56. The fastener 56 connects the wiper 36 to the auger 12 and the drive block 62 allows for the rotation of the wiper 36 as the auger 12 rotates. As can be appreciated, the wiper can be attached to the auger in other arrangements.

[0072] With reference back to FIGURE 5, an upstream face 64 of the wiper 36 includes a plurality of fastener openings 66 that receive fasteners to attach a wiper spacer 68 (FIGURE 1) to the wiper for spacing the wiper from the end face of the auger 12. In the depicted embodiment, the wiper spacer 68 is in the form of an annular ring; however, the wiper spacer can comprise a plurality of components, such as a plurality of blocks. As can be appreciated, other connection arrangements can be used.

[0073] Different sized wipers can be used with the improved cutting assembly. Different sized wipers may be desirable where different die plate and/or die openings are used. It may be desirable to have a certain shaped wiper be used in conjunction with a certain die plate and/or certain die inserts. As seen in FIGURE 2, the number of wiper blades 38 is equal the number of die openings 16; however, this is not required. In the embodiment depicted in FIGURE 2, each wiper blade 38 extends from a peripheral edge of the body of the wiper 36 a distance that is nearly, the same as and/or slightly greater that the diameter of each die opening 16. In one non-limiting design, the wiper blade is at least 80% as large as the cross-sectional area of the die opening. In another non-limiting design, the wiper blade is at least 100% as large as the cross-sectional area of the die opening. The wiper blades are also arrangement to be in contact with the inner face of the die plate or be closely oriented to the die plate. Typically the edge of the wiper blade that is closest to the die plate is no more than about 0.25 inch from the die plate.

[0074] Reference will now be made to an alternative embodiment of a wiper as shown in FIGURES 9-12, where like numerals having a primed (') suffix will refer to like components of the aforementioned wiper. With reference to FIGURE 9, a wiper 36' includes a plurality of wiper blades 38' radially extending from a periphery of a substantially frustoconical body 40'. The wiper blades 38' extend a greater radial distance from the periphery of the wiper body as compared to the wiper blades shown in the embodiment disclosed in FIGURES 5-8. In this embodiment, the wiper blades 38' extend a distance from the peripheral edge of the body 40' a distance greater than the diameter of the die openings 16 shown in FIGURE 2. With reference to FIGURE 12, each wiper blade 38' includes a leading surface 44' and a trailing surface 46'. Similar to the embodiment depicted in FIGURES 5-8, the leading surface 44' encourages material into the dies 18 (FIGURE 1). Each wiper blade 38' also includes an axial end surface 48' that contacts or is positioned closely adjacent to the die plate 14. With reference to FIGURE 10, the wiper 36' also includes a bowl-shaped downstream surface 52'. The wiper 36' also includes a fastener opening 54' beginning in the downstream face 52' and the drive block opening 58' extending from a front face 64'. Fastener openings 66' extend into the body from the front face 64' to attach a wiper spacer, such as wiper spacer 68 in FIGURE 1, to the wiper 36'. The wiper can take many configurations other than those described above.

[0075] With reference back to FIGURE 1, a rotating cutter head 80 having a plurality of cutter blades or knives 82 cuts the extruded material into cut products P. The cut products P can take a number of different shapes dependent upon die 18 used to form the cut product. The length of the cut product is controlled by way of the systems that will be described below.

[0076] The cutter head 80 is rotated by a motor 84. The motor 84 receives power from a power source (not shown). An output shaft 86 extends from the motor 84. A shaft coupling 88 connects the output shaft 86 of the motor 84 to a drive shaft 92. As more clearly seen in FIGURE 13, the wiper 80 includes a central opening 94 for receiving the drive shaft 92; however, other arrangements can be used.

[0077] The drive shaft 92 extends through a bearing plate 96 having bearings 98 and 102 disposed therein. The drive shaft 92 can also include a forward threaded section 104 that nuts 106 can threadingly engage to control the location of the cutter head 80 with respect to the die plate 14. The cutter head 80 can also include radial openings 108 (only one is shown in FIGURE

13) for receiving fasteners 112 (FIGURE 1) for securing the cutter head 80 to the drive shaft 92. As can be appreciated, the cutter head can be connected to the drive shaft in other ways.

[0078] With reference to FIGURE 13, a plurality of cutter blades or knives 82 connect to and radially extend from an upstream face 120 of the cutter head 80. With reference to FIGURE 14, each cutter knife 82 includes a lower body portion 122 and a blade 124 extending from the lower body portion. The lower body portion 122 is received in appropriately shaped recesses 126, which in the depicted embodiment are rectangular, formed in the body of the cutter head 80 at the upstream face 120. Each lower body portion 122 also includes fastener openings 128 that receive fasteners 132 (FIGURE 1) to attach each cutter knife 82 to the cutter head 80. As is apparent, once a blade 124 dulls, the cutter knife 82 can be replaced from the cutter head 80 by removing the fasteners 132 (FIGURE 1) that attach the cutter knife 82 to the cutter head 80. As can be appreciated, the cutter knifes can be connected to the cutter head by other arrangements. In an alternative embodiment, the cutter head 80 and the cutter knifes 82 can be formed as an integral unit.

[0079] With reference to FIGURE 18, the blade 124 includes a sharpened or primary cutting edge 134 that lies in the same plane as the upstream face 120 of the cutter head 80, or slightly in front of the upstream face of the cutter head. The primary cutting edge is used as the principal cutting surface of the blade. The slope angle of the primary cutting edge is used to effectively cut the extruded product. Typically the slope of the primary cutting edge is about 25-35°. The blade also can a rake surface next to the primary cutting edge, not shown, that has a rake angle. The rake surface is positioned on the same side of the one or more cutting blades as the primary cutting surface. Typically, the primary cutting edge transitions into the rake surface; however, this is not require. The rake angle is less than the slope angle of the primary cutting surface. The rake angle is used in part to create a trajectory of the material after it has been cut by the primary edge. This trajectory of the material is used to more the material off of the cutting blade and/or to through the cut material to a desired location. Typically the rake angle is about 15-25°. The blade can also include a clearance surface that has a clearance angle. The clearance surface is positioned on the opposite side of the one or more cutting blades as the primary cutting edge, and the rake surface when used. The clearance surface is designed to facilitate in enable the cutting blade to clear the continuously extruded product. Once the primary cutting edge has cut a portion of the extruded product, more extruded product moves out from the die plate openings. This front end of the extruded material can cause interference with the blade, and thereby cause improper rotation speeds of the rotating cutter head 80. The clearance angle on the blade is selected so as to enable the back side of the blade to easily move past the front end of the extrude product and thereby facilitate in the proper operation of the rotating cutter head and proper and consistent rotation speeds of the rotating cutter head. Typically the slope angle of the clearance surface is about 8-15°. With reference to FIGURE 4, the blade 124 is positioned closely adjacent an outlet end of the die 18 so as to cut the cut product P to the desired length. Typically the primary cutting edge is less than about 0.5 inch form the face of the die plate. The rate at which material to be extruded enters the die 18 and the rotational velocity of the cutter head 80 controls the length of the cut product P.

[0080] When the pressure on the extruded material increases, the material travels at a faster rate through the die 18. Conversely, when the pressure on the extruded material reduces, the extruded material passes at a slower rate through the die 18. By detecting the pressure of the material as it enters into one or more openings in the die plate 14, it can be determined whether the material is accelerating, decelerating, or maintaining a constant velocity through the die 18. As illustrated in FIGURE 2, pressure transducers 150 are inserted into radial openings 152 in the spacer 26 to detect the pressure of the material as it enters into one or more of the dies 18. With reference to FIGURE 2, a plurality of pressure transducers 150 can be supplied into the radial openings 152; however, this is not required. Plugs 154 can be inserted into radial openings 152 where no pressure measurements are being made. The pressure transducers 150 can communicate with a controller 156, which communicates with the motor 84 and/or auger motor 158. If it is detected that the pressure has decreased, the speed at which the motor 84 rotates the cutter head 80 can be accordingly decreased. If it is found that the pressure of the material has increased, the speed at which the motor 84 rotates the cutter head 80 can be accordingly increased. Furthermore, if it is found that the pressure is constant, the speed at which the motor 84 rotates the cutter head 80 can be maintained constant. As a result, the control of the cutter head 80 can be controlled as a function of the pressure detected upstream of the dies 18 through the controller 156. It may be desirable to also control the rate at which the auger 12 rotates as a function of the pressure upstream from the dies 18. This can be accomplished by allowing the controller 156 to communicate with a motor 158 that drives the auger 12. It also may desirable to control the rate at which the cutter head 80 rotates as a function of the rate at which the auger 12 rotates. This can also be accomplished by the controller 156.

[0081] The rotational speed of the output shaft 86 of the motor 84 can be determined using a sensor 160 such as, but not limited to, a digital encoder available from US Digital Corporation. The sensor 160 communicates with the controller 156 which communicates with the motor 84. Accordingly, rotational speed of the output shaft 86, which is connected to the drive shaft 92, can be controlled.

[0082] A sensor 170 can also be supplied to check the length of the cut product P. In one non-limiting embodiment, the sensor can be in the form of a camera, or the like, that can detect the dimensions of the cut product P. The sensor 170 communicates with the controller 156. The sensor 170 can send a signal to the controller 156 in response to the detected dimensions of the cut product P. Accordingly, the rotational speed of the cutter head 80 can be adjusted in response to the detected dimensions of the cut product P.

[0083] In addition to controlling the rate at which material is extruded through the dies 18and the rotational speed of the cutter head 80, various other features can also be incorporated into the cutting assembly. A switch 180 can be provided to communicate with the controller 156. To replace the dies 18, the cutter knives 82, the die plate 14, etc., the assembly is typically disassembled. The die holder 28 and the bearing plate 96 attach to a trolley plate 182. The trolley plate 182 connects to a trolley assembly for moving the cutting assembly. As seen in FIGURE 2, a plurality of fasteners 184 connect the die holder 28 to the trolley plate 182. As seen in FIGURE 3, a plurality of fasteners 186 also attach the bearing plate 96 to the trolley plate 182.

[0084] In the depicted embodiment, the switch 180 includes a button 190 that contacts a dowel 192 disposed in a dowel opening 194 formed in the die holder 28. The dowel opening 194 runs parallel to the central axis of the die holder 28, which is aligned with the drive shaft 92. With reference to FIGURE 2, a radial bore 196 extends from a periphery of the die holder 28 into the dowel opening 194. The radial opening 196 receives a fastener 198 which can be received in a notch 202 formed in the dowel 192.

[0085] Removal of the die holder 28 results in the button 190 extending outward from the switch 180, which sends a signal to the controller 156 to cut power to the motor 84. The positioning of the button 190 can be adjusted by adjusting the dowel 192 by loosening the fastener 198 in the notch 202 and adjusting the dowel accordingly. As can be appreciate, other arrangements can be used to deactivate the motor 84.

[0086] Another sensor 210 can be added to the fastener 32 that connects the die holder 28 to the spacer 26 and the auger housing 22. The sensor 210 can be a load cell-type sensor that is trapped between the die holder 28 and a nut 212. The sensor 210 can detect forces from the die holder 28 and send a signal to the controller 156 to control power delivery the motor 84.

[0087] The cutting assembly can also include a mode control 220. The mode control 220 is in communication with the controller 156. One mode can be a manual mode wherein the speed of the cutter head 80 is set and maintained at a substantially constant speed throughout an extrusion process. The improved cutting assembly can also include an automatic mode wherein the speed of the cutter head 80 is adjusted based upon the detected pressure of the material prior to and/or as it is being extruded through the die, the detected velocity of the material prior to, during, and/or after being extruded through the die, and/or detecting the actual and/or calculated length of the cut material. The improved cutting assembly can include one or more measured and/or adjustable parameters to adjust the length of the extruded material being cut so as to obtain a desired length of the cut material, calibrate the pressure so that the speed control for the cutter head 80 is properly adjusted based upon a particular pressure, adjust the delay so as to delay the adjustment of the speed of the cutter head 80 to account for the time period in which the material travels into and through a die, etc.

[0088] The invention has been described with reference to the preferred embodiments. These and other modifications of the preferred embodiments as well as other embodiments of the invention will be obvious from the disclosure herein, whereby the foregoing descriptive matter is to be interpreted merely as illustrative of the invention and not as a limitation. It is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims.

CLAIMS:

1. A cutting assembly for cutting a material extruded from a die, the assembly comprising:

a wiper adapted to connect to an auger or other material feeding arrangement, the wiper having at least one radially disposed wiper blade;

a die holder plate disposed adjacent the wiper, the die holder plate including at least opening adapted to receive a die, the wiper blade being adapted to direct material to be extruded into the opening for extrusion through the die;

a cutter head adapted to connect to a rotating member and disposed adjacent the die holder plate downstream from the at least one opening; and

at least one cutter knife connected to the cutter head for cutting material extruded from the die.

2. The cutting assembly of claim 1, wherein the wiper includes a plurality of radially disposed wiper blades.

3. The cutting assembly of claim 1 or 2, wherein the die holder plate includes a plurality of openings adapted to receive a die.

4. The cutting assembly of claims 1-3, wherein the number of wiper blades is the same as the number of openings.

5. The cutting assembly of claims 1-4, wherein the wiper is adapted to reduce pressure variations of material being directed toward the at least one opening in the die holder plate.

6. The cutting assembly of claims 1-5, wherein the at least one wiper blade is adapted to reduce or eliminate space about the at least one opening in the die plate that can harbor material to be extruded.

7. The cutting assembly of claims 1-6, further comprising a motor for rotating the

cutter head and a controller in communication with the motor.

8. The cutting assembly of claims 1-7, further comprising at least one sensor disposed upstream of the at least one opening in the die holder plate, in at least one opening in the die plate, or combinations thereof, said at least one sensor is in communication with the controller.

9. The cutting assembly of claims 1-8, wherein the controller comprises a pulse width modulator control system.

10. The cutting assembly of claims 1-9, further comprising a detector downstream from the at least one opening for detecting the length of material cut by the cutter knife, wherein the detector is in communication with the controller.

11. The cutting assembly of claims 1-10, further comprising a switch for controlling power delivery to the motor

12. The cutting assembly of claim 11, wherein the switch comprises a button that contacts the die holder plate or a component connected to the die holder plate.

13. The cutting assembly of claims 1-12, further comprising a sensor for detecting the speed at which the motor rotates, wherein the sensor is in communication with the controller.

14. The cutting assembly of claims 1-13, wherein the at least one wiper blade extends from the wiper a distance at least about equal to the diameter of the at least one opening in the die holder plate.

15. A cutting system for cutting a material extruded from a die, the system comprising:

a die holder plate including at least opening adapted to receive a die;

a cutter head rotatably mounted adjacent the die holder plate downstream from the at least one opening;

at least one cutter knife extending from the cutter head for cutting material extruded from the die;

a motor operably connected the cutter head;

a sensor disposed upstream of the at least one opening in the die holder plate, in at least one opening in the die plate, or combinations thereof; and

a controller in communication with the motor and the sensor.

16. The system of claim 15, wherein the controller comprises a pulse width modulator control system.

17. A method for cutting material extruded from a die, the method comprising:

directing material to be extruded into a die that is disposed in a die holder plate;

cutting the material after it has been extruded through the die using a rotating cutter head;

measuring at least one variable upstream from the die, in the die, down stream from the die or combinations thereof;

controlling the rotational speed of the cutter head in response to the measured variable.

18. The method of claim 17, wherein the controlling step comprises reducing the rotational speed of the cutter head in response to the measured variable.

19. The method of claim 17 or 18, wherein the controlling step comprises increasing the rotational speed of the cutter head in response to the measured variable.

20. The method of claims 17-19, further comprising reducing pressure variations of the material being directed into the die that is disposed in the die holder.

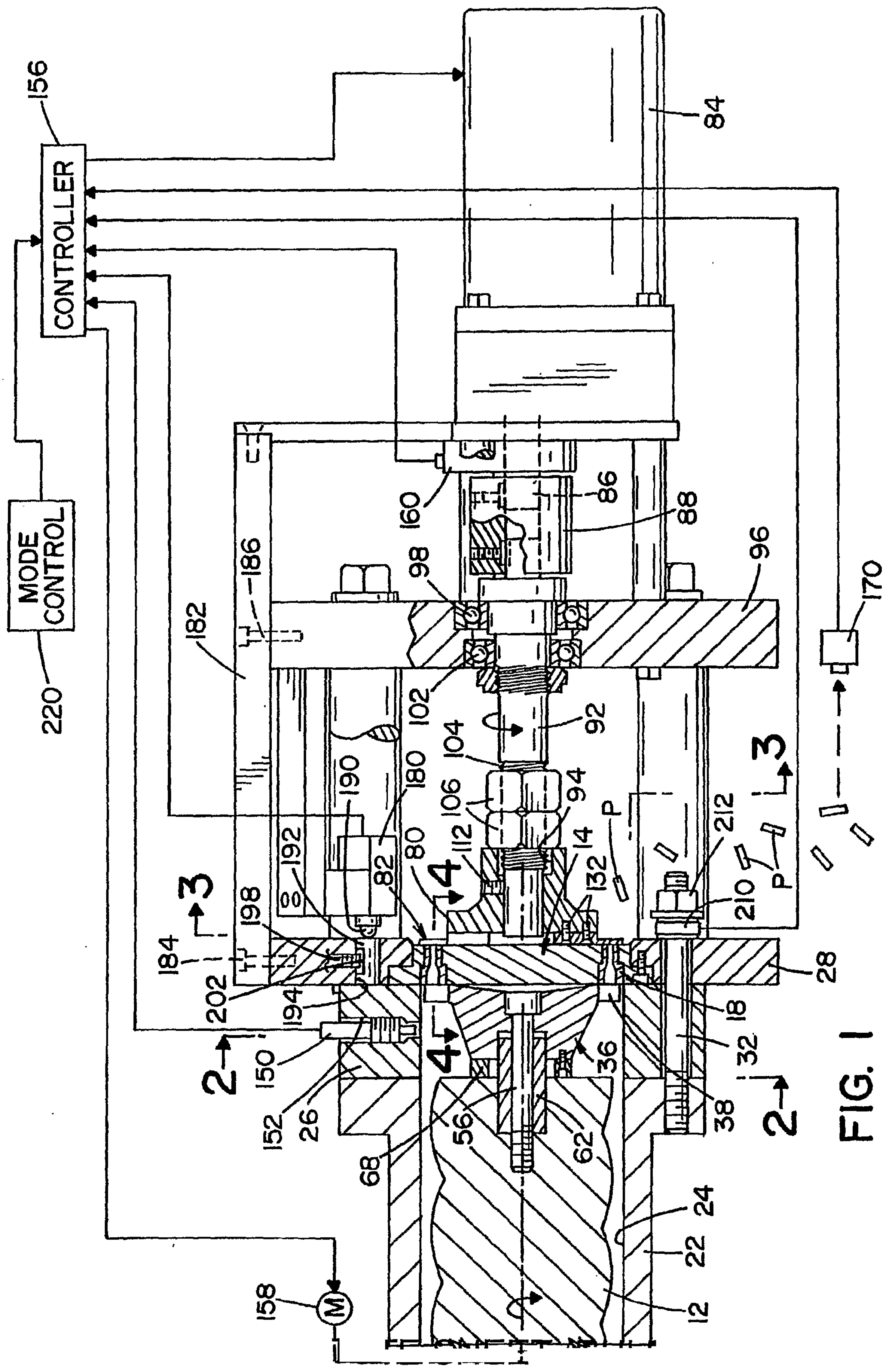

FIG. 1

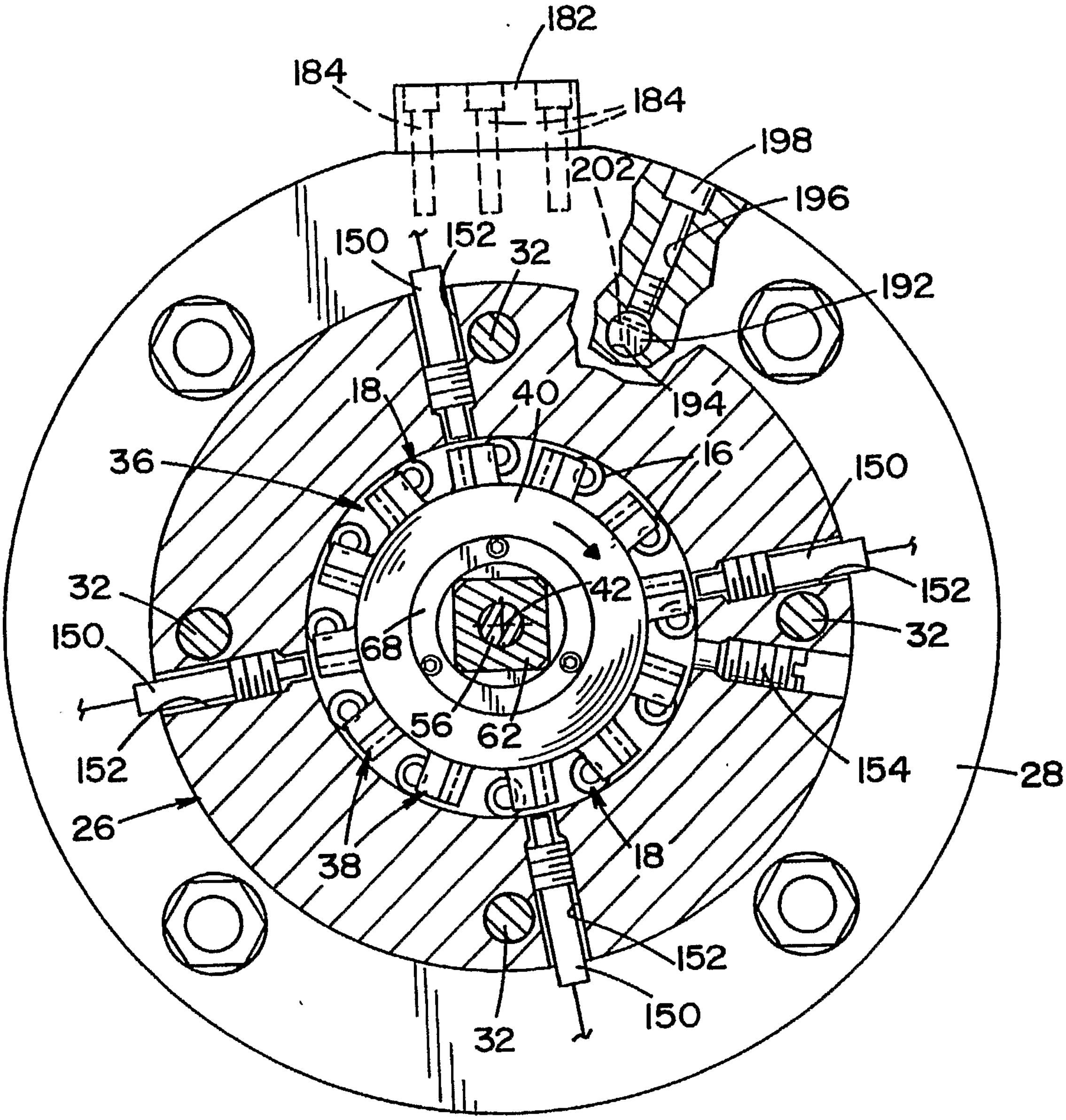
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FIG. 2

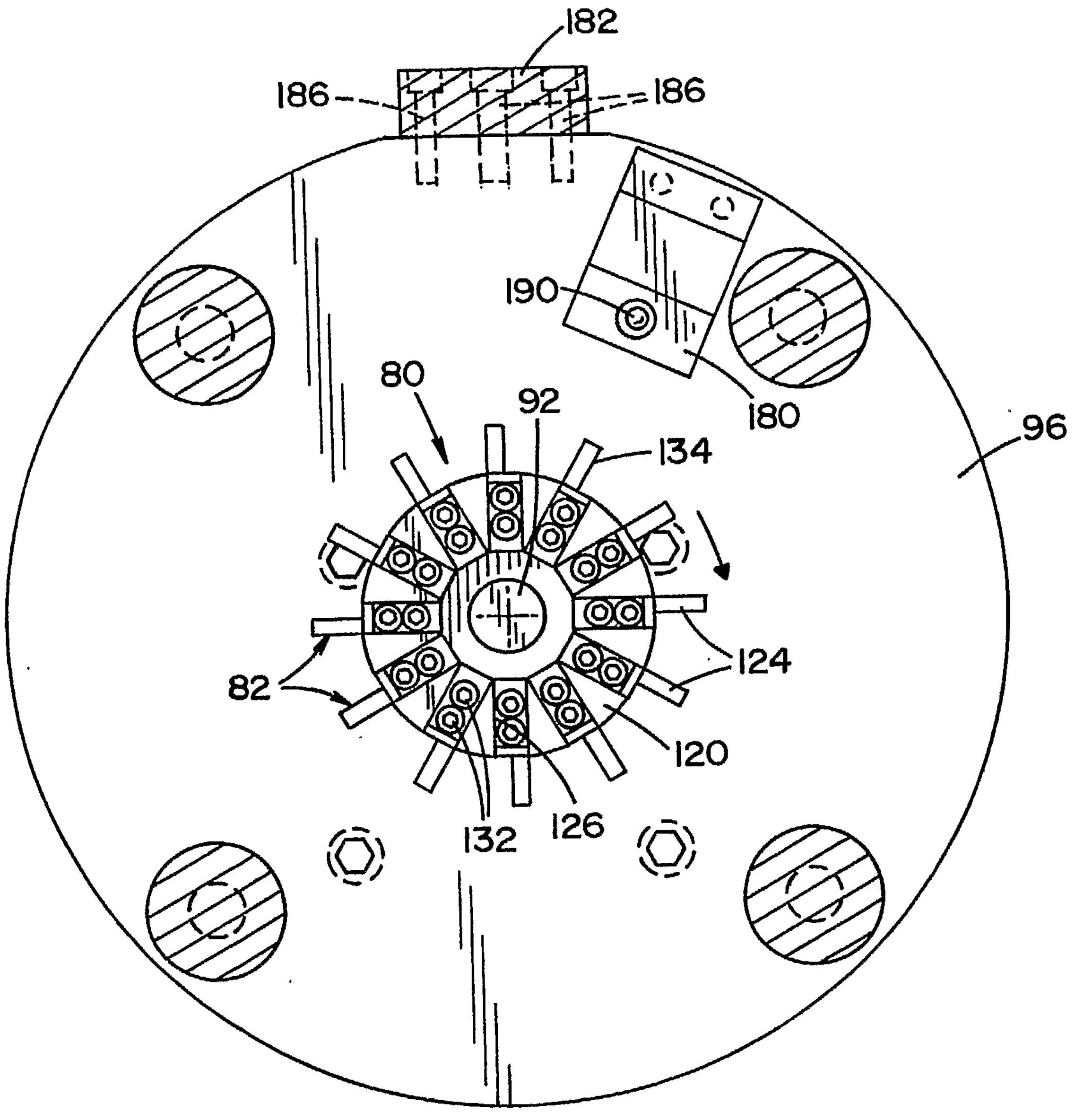
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FIG. 3

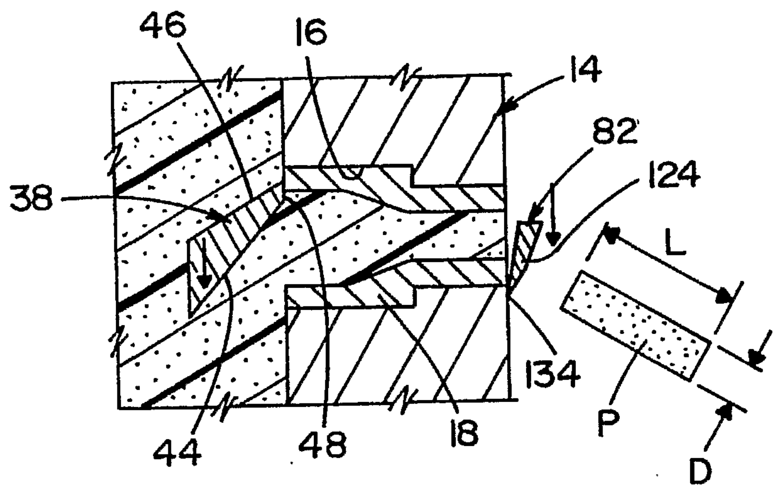
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FIG. 4

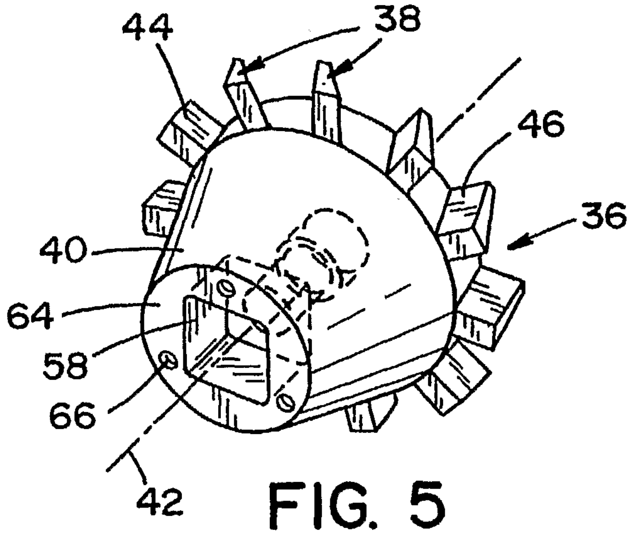

FIG. 5

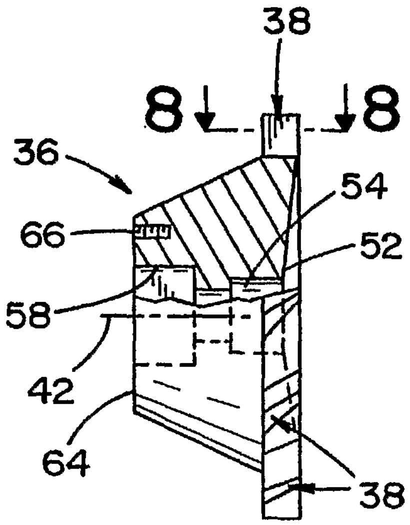

FIG. 6

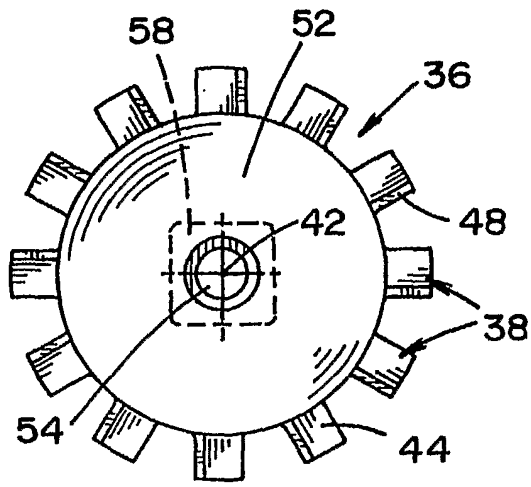

FIG. 7

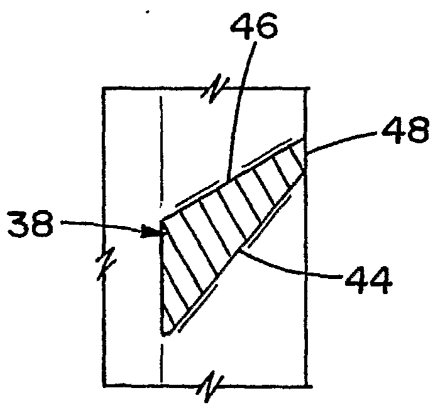

FIG. 8

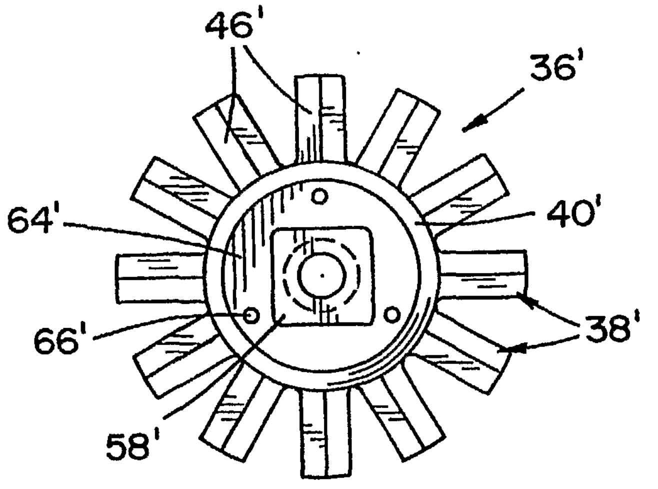

FIG. 9

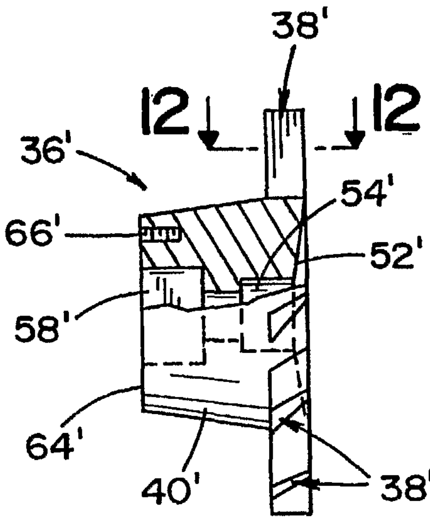

FIG. 10

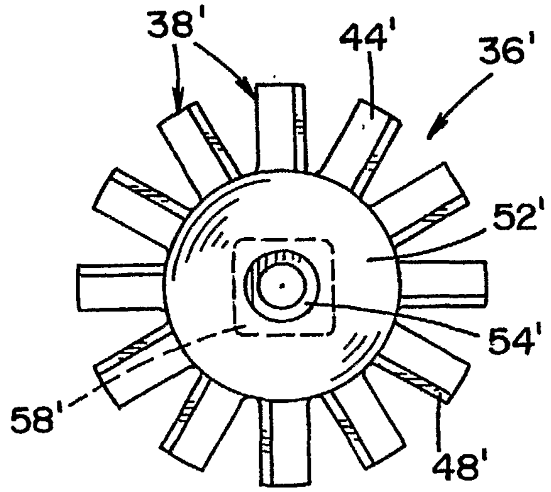

FIG. 11

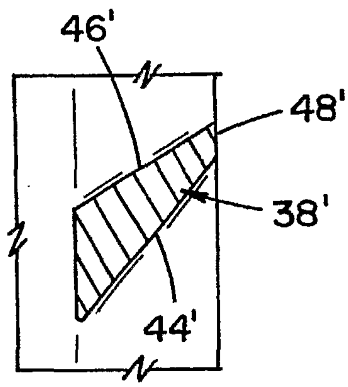

FIG. 12

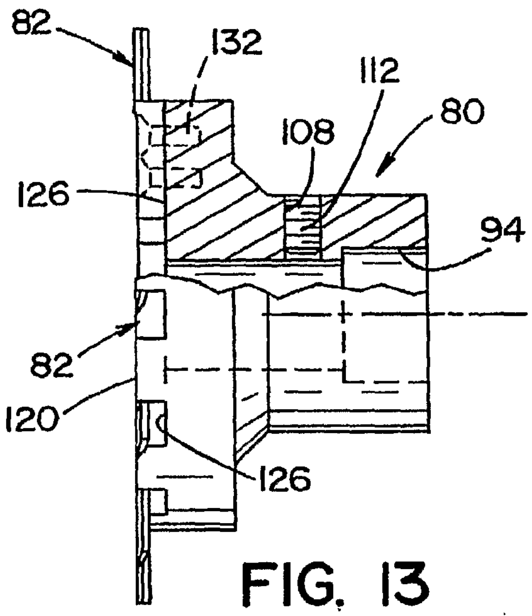

FIG. 13

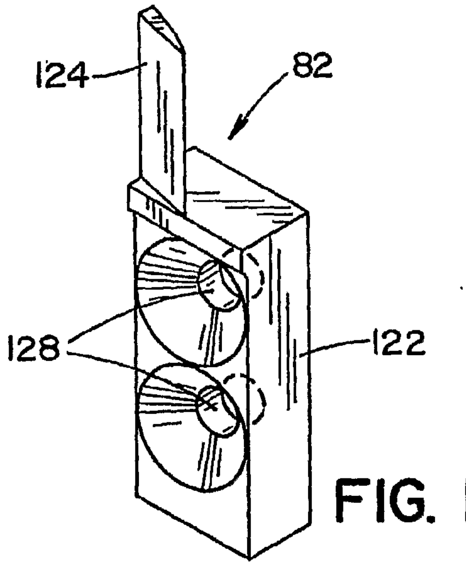

FIG. 14

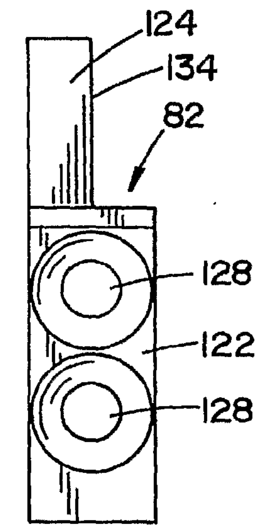

FIG. 15

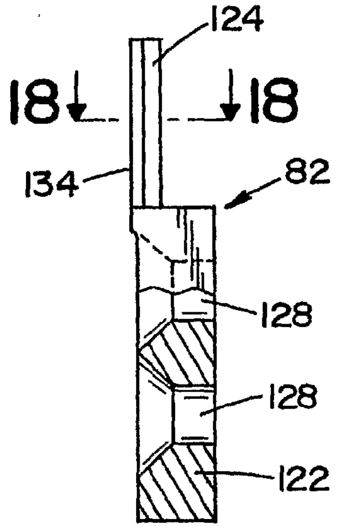

FIG. 16

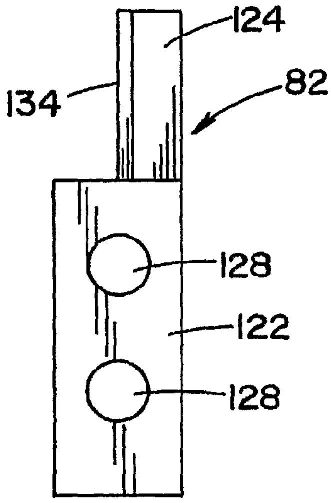

FIG. 17

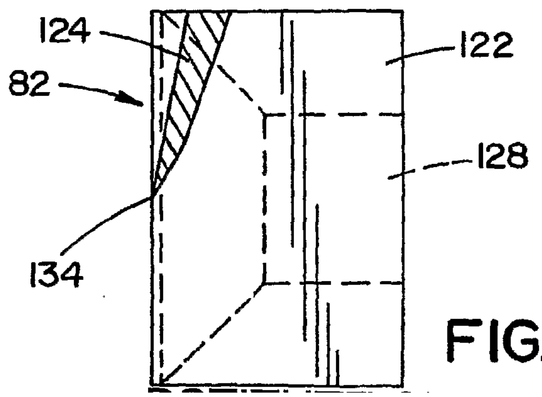

FIG. 18

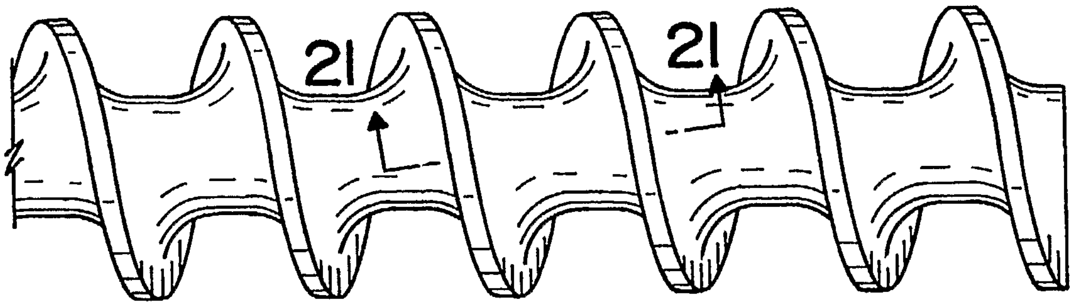

FIG. 19

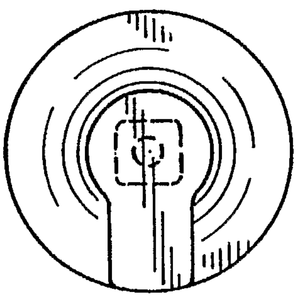

FIG. 20

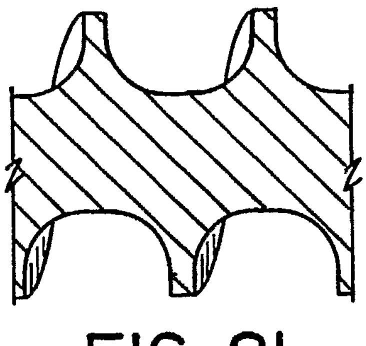

FIG. 21

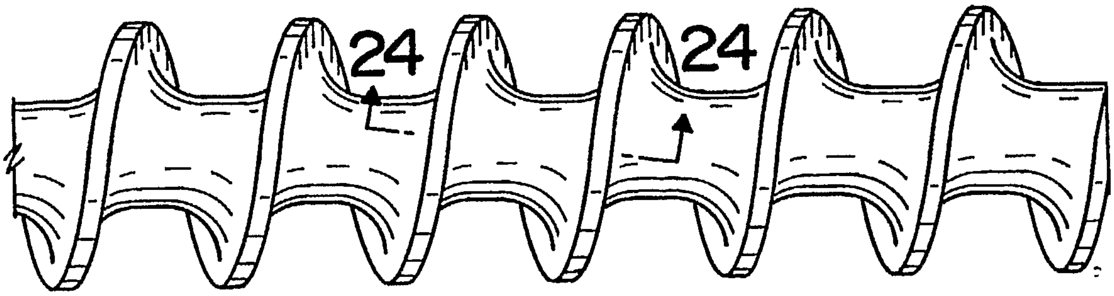

FIG. 22

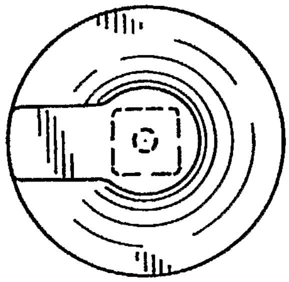

FIG. 23

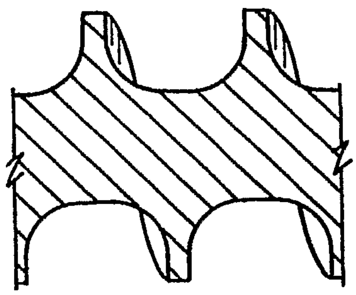

FIG. 24

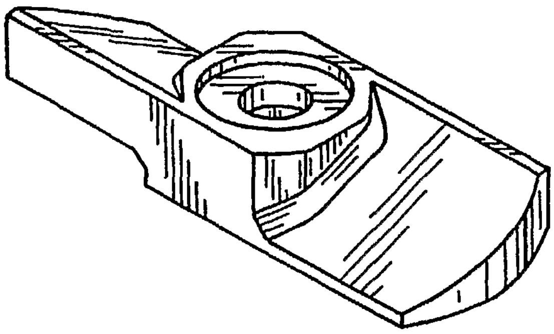

FIG. 25

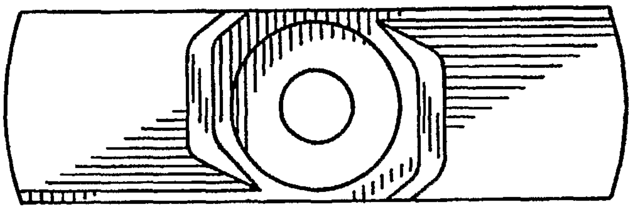

FIG. 26

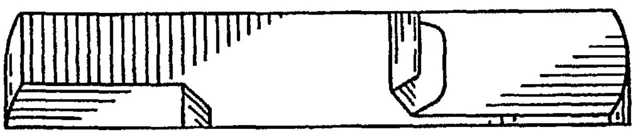

FIG. 27

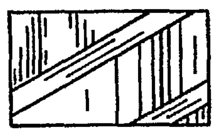

FIG. 28

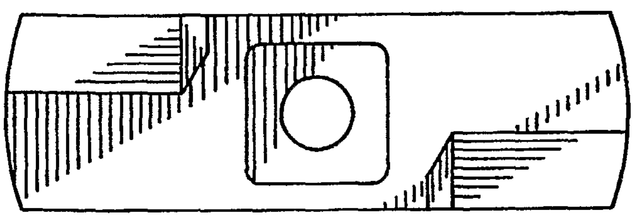

FIG. 29

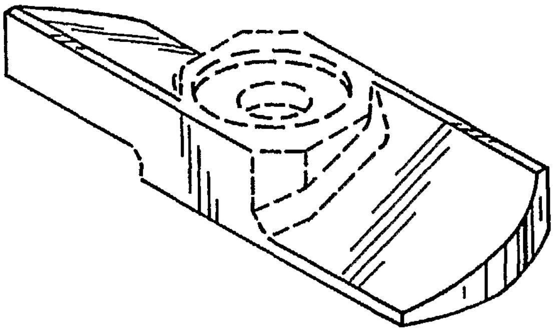

FIG. 30

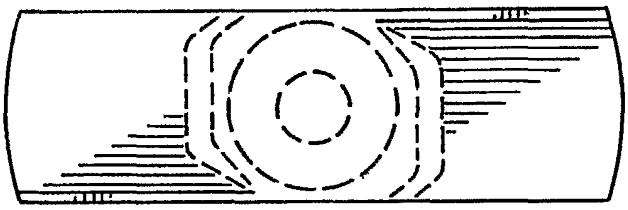

FIG. 31

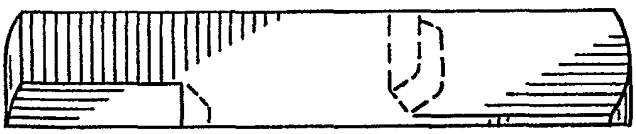

FIG. 32

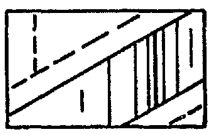

FIG. 33

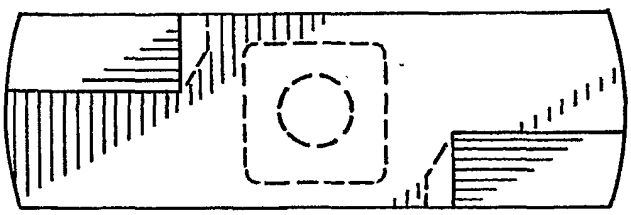

FIG. 34