Oct. 27, 1959 J. C. HOLM 2,910,286

ROTARY KILN DRIVE MECHANISM

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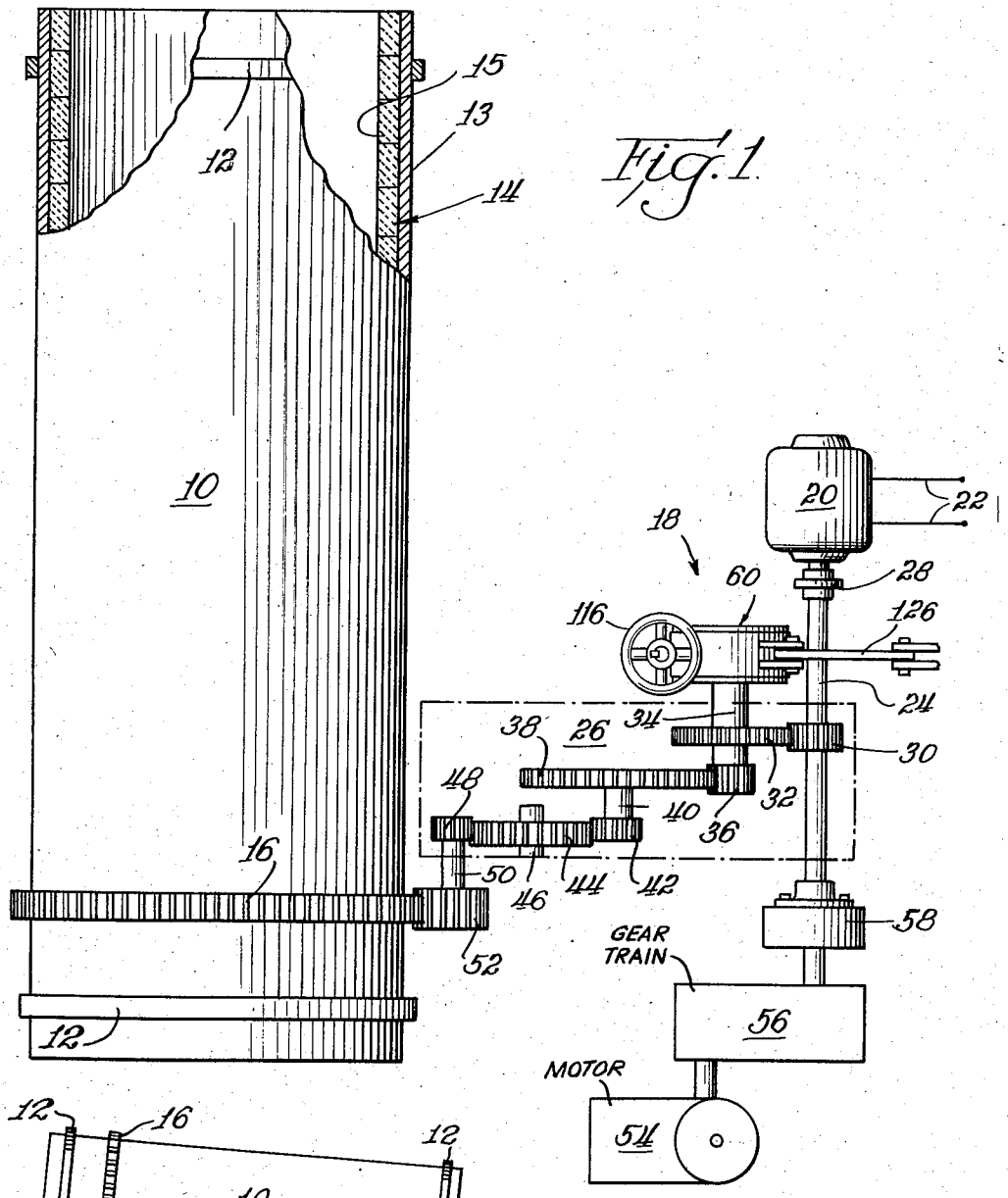


Fig. 1

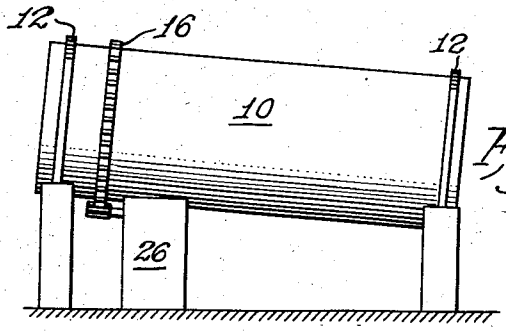


Fig. 4

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Fig. 2.

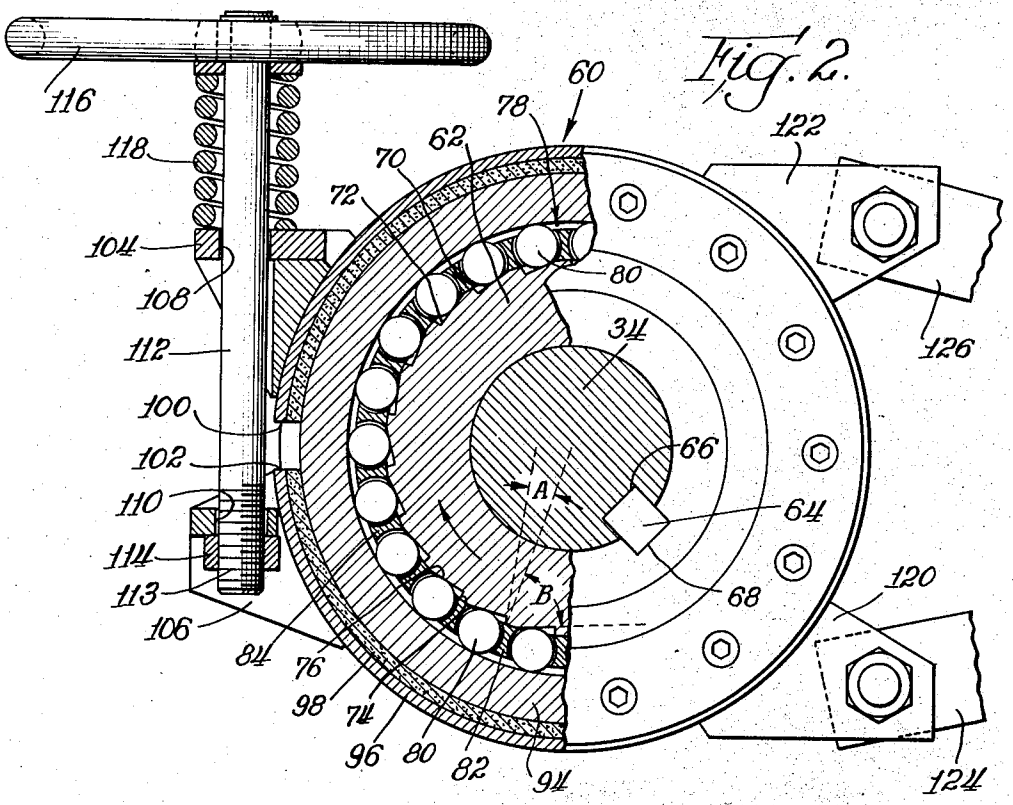
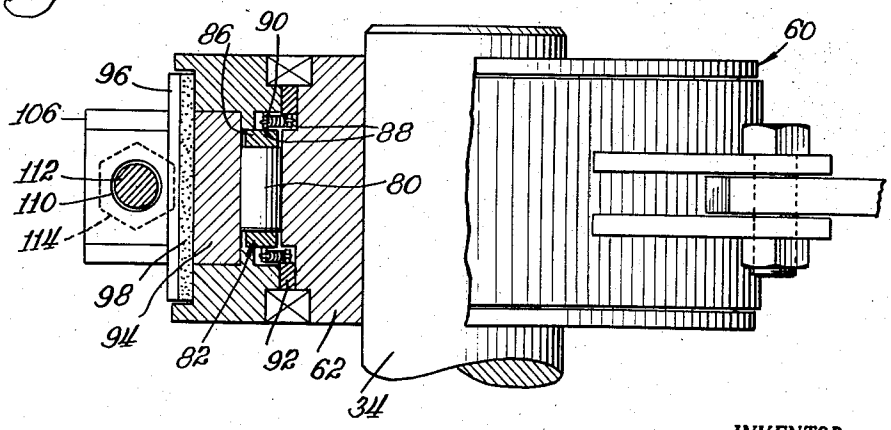


Fig. 3.



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United States Patent Office

2,910,286

Patented Oct. 27, 1959

2,910,286

ROTARY KILN DRIVE MECHANISM

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Application October 27, 1955, Serial No. 543,158

4 Claims. (Cl. 263—33)

The present invention relates to rotary kilns and mechanisms for rotating a rotary kiln. More particularly, the present invention relates to mechanisms for rotating rotary kilns, such as those used in a cement and other manufacturing processes.

The process generally used in manufacturing cement employs a rotary kiln of considerable length, usually disposed on an incline. A homogeneous mixture of two materials, one rich in lime and the other rich in silica, is fed into the high end of the kiln. The kiln is continuously rotated, causing the mixture to pass from the high end of the kiln through the different zones of the kiln, known as the dehydration zone, the calcinating zone, and the clinkering zone. Heat is applied to the kiln as it rotates to produce fusion of the mixture fed into the kiln in the form of a cement clinker.

It is general practice to rotate the kiln by an electric motor coupled to a gear rim which surrounds the kiln. The electrical power for the motor is usually obtained from conventional power lines, although an electrical generator could be employed. In either case, occasional power failures are apt to occur.

A power failure which lasts a substantial length of time will not only spoil the batch in the kiln, but it may also necessitate a costly repair operation on the kiln. Once the kiln stops rotation, the kiln shell might warp, being hot at bottom and cold on top. In some cases, the refractory brick liner on the interior cylindrical surface of the kiln is damaged and must also be replaced in order to place the kiln in working condition. It is one of the objects of the present invention to provide a drive mechanism for a rotary kiln using an electrical motor in which electrical power failures do not stop rotation of the kiln.

Eventually, even with normal operation of the kiln, the refractory brick liner within the kiln must be replaced. It is always a practice to replace the bricks on the bottom and lower portions of the kiln. Subsequently, the kiln is rotated and the other portions are lined. This is difficult with presently used kiln drive mechanisms, since they are free to rotate in either direction. It is, however, desirable under certain conditions when replacing the refractory brick liner to rotate a kiln in the opposite direction to its normal operation, as will be explained hereinafter. It is a further object of the present invention to provide a drive mechanism for a rotary kiln which is normally free to rotate only in one direction, and which may be adjusted to rotate in either direction.

Further objects and advantages of the present invention will be apparent from a further reading of this disclosure, particularly when viewed in the light of the drawings, in which:

Figure 1 is a schematic view of a rotary kiln and a drive mechanism for the production of cement clinkers constructed according to the teachings of the present invention;

Figure 2 is a sectional view of the backstop mechanism illustrated schematically in Figure 1;

Figure 3 is a plan view, partly cut away and in section, of the backstop mechanism illustrated in Figure 2; and

Figure 4 is a front elevational view of the rotary kiln and drive mechanism illustrated in Figure 1.

As illustrated in Figure 1, a rotary kiln is supported on suitable bearings **12**, usually in an inclined position. Rotary kilns are generally from six to twelve feet or more in diameter and eighty to five hundred feet long. The kiln **10** is formed by a hollow cylinder **13**, and is lined with a layer **14** of refractory bricks **15** which are disposed in abutting relationship. Since the use of rotary kilns in the production of cement is well known and forms no part of the present invention, the details of the devices for charging the batch into the rotary kiln and discharging it from the kiln, as well as the details of the cement manufacturing process have not been specifically described. The kiln **10** is provided with an annular gear rim **16** which extends about the periphery of the kiln **10** and is coupled to a drive mechanism **18**.

The drive mechanism **18** obtains rotary energy from an electric motor **20** which is electrically connected to a power line, designated **22**, which conducts electrical energy from a generating plant to the electric motor in the conventional manner. The motor **20** is coupled to a first rotatable shaft **24** of a main speed reducing gear train **26** by a flexible coupler **28**. A first pinion gear **30** is secured to the first shaft **24**, and this pinion gear **30** is meshed with a first spur gear **32** which is secured to a second rotatable shaft **34** in the gear train **26**. A second pinion gear **36** is also secured to the second shaft **34**, and this pinion gear **36** is meshed with a second spur gear **38** which is secured to a third rotatable shaft **40**. A third pinion gear **42** is secured to the third shaft **40** and meshed with a third spur gear **44** which is secured to a fourth rotatable shaft **46**. The spur gear **44** is meshed with a direction reversing gear **48** which is secured to a fifth rotatable shaft **50**. A pinion gear **52** is secured to the fifth shaft **50** and meshed with the gear rim **16** on the kiln **10**.

There has been coupled a gasoline motor **54** to the speed reducing gear train **26**, and hence to the kiln **10**, in order to provide continuous rotation of the kiln **10** in the event of failure of the electric motor **20** to supply the requisite rotational power. The gasoline motor **54** is mechanically connected to the driven end of a second speed reducing gear train **56**, and the driving end of the gear train **56** is connected mechanically to the driven end of a free-wheeling clutch **58**. The driving end of the free-wheeling clutch **58** is mechanically connected to the first shaft **24** of the gear train **26**, thus coupling the gasoline motor **54** to the kiln **10**.

The free-wheeling clutch **58** disengages the gasoline motor **54** from the kiln **10** as long as the angular velocity of the driving end of the clutch exceeds the angular velocity of the driven end of the clutch, the direction of rotation of the driving and driven ends of the free-wheeling clutch being the same. However, if the electric motor **20** fails to supply sufficient energy, the angular velocity of the driving end of the free-wheeling clutch will fall below that of the driven end of the clutch, and power will be supplied by the gasoline motor **54** to the kiln **10**. Since free-wheeling clutches of the type here described are well known, and the details of the particular free-wheeling clutch form no part of the present invention, these details have not been set forth.

A backstop mechanism **60** is connected to the second shaft **34** of the gear train **26** and prevents rotation of the kiln **10** in the direction opposite to the operating direction. The shaft **34** is secured within a hollow member **62** by a key **64** disposed within slots **66** and **68** in the shaft **34** and member, respectively. The outer surface of the member **62**, designated **70**, is coaxial with the

shaft 34, and this surface 70 is provided with a plurality of indentations 72. Each of the indentations has a flat surfaced trailing edge 74 and a flat surfaced leading edge 76, the direction of rotation being indicated by the arrow in Figure 2. The plane of each trailing edge forms an acute angle with the plane extending through the axis of the shaft 34 and the axis formed by the intersection of the trailing edge plane and the outer surface 70 of the hollow member 62, this angle being shown in dotted lines in Figure 2 and designated A. In like manner, an angle B is formed between the radial plane and the plane of the leading edge 76 of the indentations 72, this angle also being indicated by dotted lines in Figure 2 and being much greater than the angle A. It has been found that the trailing edge 74 of the indentations 72 must be steeper than the leading edges 76, and more specifically, angle A must be less than 45 degrees and angle B greater than 45 degrees for the backstop mechanism to function in its intended manner, as will be later apparent.

A roller assembly 78 is disposed about the outer surface 70 of the hollow member 62. The roller assembly has a plurality of roller bearings 80 disposed in a race 82, one roller 80 confronting each of the indentations 72 in the outer surface 70 of the hollow member 62. The race 82 has separation members 84 between adjacent rollers 80, the surfaces of the separation members 84 conforming with the surfaces of the rollers 80, and these separation members 84 are interconnected by links 86 which are pivotally connected between adjacent separation members 84 at each end of the rollers 80. The links 86 are also connected to fingers 88 by helical springs 90, and the fingers 88 are secured to a pair of annular bushings 92 which are coaxial with and secured to the hollow member 62. As a result of this construction, the roller bearings 80 rotate about the axis of the shaft 34 in positions which are limited to a range of movement, namely approximately the length of the indentation 72.

A cylindrical outer race 94 is disposed coaxially about the hollow member 62 and abuts the roller bearings 80. A brake shoe 96 surrounds the outer race 94, and a layer of brake lining 98 abuts the outer race 94 and the brake shoe 96. The brake shoe 96 is in the form of a strip disposed in a generally cylindrical shape with its ends 100 and 102 confronting each other but spaced from each other, as illustrated in Figure 2. A bracket 104 is attached to the brake shoe 96 adjacent to its end 100, and a second bracket 106 is attached to the brake shoe 96 adjacent to its other end 102. Both of the brackets 104 and 106 are provided with confronting apertures 108 and 110, respectively, and a shaft 112 extends through the two apertures 108 and 110, the portion 113 of the shaft disposed within the aperture 110 being threaded and threadedly engaged with a nut 114 mounted to the bracket 106. A wheel 116 is secured to the shaft 112 on the opposite side of bracket 104 from the threaded portion 113 of the shaft 112, and a helical spring 118 surrounds the shaft 112 between the bracket 104 and the wheel 116 and abuts the wheel 116 and bracket 104.

The brake shoe 96 is anchored to the support member for the speed reducing gear train 26, in the present instance the surface of the earth, to prevent rotation of the brake shoe 96. A pair of brackets 120 and 122 are mounted to the brake shoe 96 on the opposite side of the brackets 104 and 106, as shown in Figure 2, and a pair of arms 124 and 126 are secured to the brackets 120 and 122, respectively, at one end and to the supporting member, or earth, at the other end, as illustrated in Figure 1.

Since the electric motor 20 revolves the first shaft 24 of the gear train 26 at a more rapid rate than the gasoline motor 54 would through the speed reducing gear train 56, the kiln 10 is rotated entirely by the energy from the electric motor 20. If electric power fails at any time during the processing of the batch, or the electric motor 20 fails for any reason, the free-wheeling clutch couples the gasoline motor 54 to the first shaft 24. The gasoline motor then is started and the kiln 10 continues to rotate, but at a slower rate than when driven by the electric motor 20. The rotation rate of the kiln 10 when driven by the gasoline motor 54, however, is sufficient to prevent damage to the kiln.

During normal operation of the kiln, the direction of rotation of the second shaft 34 of the gear train 26 is clockwise, as illustrated in Figure 2 by the arrow. The roller bearings 80 under these conditions are revolving in the deepest portions of the indentations 72, since the rollers 80 tend to move down the leading edges 76 of the indentations 72. The brake shoe 96 applies pressure to the outer race 94 as a result of the tension placed on the brake shoe by the shaft 112 and wheel 116; however, this tension is adjusted by positioning the wheel 116 to be insufficient to substantially retard rotation of the roller bearings 80 when the second shaft 34 is revolving in the forward direction. However, any attempt to rotate the shaft 34 in the reverse direction, causes the roller bearings 80 to become wedged between the leading edges 76 of the indentations 72 and the outer race 94, thus preventing rotation of the hollow member 62 in the reverse direction. Sufficient tension is applied to the brake shoe 96 by the shaft 112 and wheel 116 to completely stop rotation of the roller bearings 80 under these conditions.

When the refractory brick liner 14 is to be replaced, workmen are able to continually work on the lower portions of the kiln, since the kiln 10 may be rotated in its normal operating direction, but resists rotation in the reverse direction regardless of the weight distribution in the kiln 10 because of the backstop mechanism 60. It is often desirable to reverse the rotation of the kiln 10 for a short angular distance when the liner 14 is being completed in the kiln. This is accomplished by merely releasing the tension on the brake shoe 96 by adjustment of the wheel 116, and hand positioning the kiln 10 into the desired position.

From the foregoing disclosure, the man skilled in the art will readily devise many modifications and improvements upon the device herein set forth, including applications for the device in arts other than cement manufacturing. It is therefore intended that the scope of the present invention be not limited by the foregoing disclosure, but rather only by the appended claims.

The invention claimed is:

1. A rotary kiln comprising a drum, a brick liner disposed on the inner surface of the drum, means for rotatably mounting the drum at an incline to the horizontal, a drive mechanism mechanically coupled to the drum including a motor, and a backstop mechanism coupled to the kiln to prevent rotation of the kiln in the reverse direction including a shaft coupled to the first motor, a hollow member provided with indentations on its outer surface secured coaxially about the shaft, a round bearing disposed adjacent to each indentation, an outer race disposed coaxially with the shaft and adjacent to the round bearings, and releasable braking means operatively associated with the outer race to prevent rotation thereof relative to the drive mechanism.

2. A rotary kiln comprising a support member, a drum rotatably mounted to the support member at an incline to the horizontal, a brick liner disposed on the inner surface of the drum, a drive mechanism mounted to the support member and mechanically coupled to the drum including a motor, and a backstop mechanism coupled to the kiln to prevent rotation of the kiln in the reverse direction, said backstop mechanism including a member coupled to the kiln provided with a cylindrical surface having indentations thereon, said indentations having steeper trailing edges than leading edges, a round bearing disposed adjacent to each indentation, an outer race disposed coaxially about the member and adjacent to the round bearings, a brake shoe disposed coaxially about the outer race and mounted to the sup-

port member, and means to apply and maintain tension on the brake shoe.

3. A drive mechanism for a rotary kiln comprising a support member, an electric motor mounted to the support member, a free-wheeling clutch having a driven and driving side, a first shaft connecting the electric motor to the driving side of the free-wheeling clutch, a gasoline motor mounted to the support member, a first speed reducing gear train connected between the gasoline motor and the driven side of the free-wheeling clutch, said clutch coupling the gasoline motor to the first shaft only when the angular velocity applied to its driven side exceeds the angular velocity applied to its driving side and both angular velocities are in the same direction, a first pinion gear secured to the first shaft, a second shaft, a first spur gear secured to the second shaft and meshed with the first pinion gear, a backstop mechanism having a hollow member secured about the second shaft having a plurality of indentations at a common distance from the axis having trailing edges forming an angle no greater than 45 degrees with the radius from the axis of the member to the intersection of the trailing edge of the indentation and the outer edge of the member and leading edges forming an angle greater than 45 degrees with the radius from the axis of the member to the intersection of the leading edge of the indentation and the outer edge of the member, a first annular bearing race mounted coaxially with the hollow member, a round bearing disposed adjacent to each indentation in the hollow member and rotatably mounted in the first race, a second bearing race mounted coaxially with the first race and abutting the bearings mounted in the first race, a brake shoe disposed about the second race and mounted to the support member, said shoe having spaced confronting ends, a layer of brake lining disposed between the brake shoe and the second race, a pair of brackets secured to the brake shoe adjacent to the ends thereof, the first of said brackets having a threaded aperture therein and the second bracket having an aperture, a third shaft slidably disposed in the aperture in the second of the brackets and threadedly engaged in the aperture in the first bracket, a wheel secured to the third shaft confronting the side of the first bracket opposite to the second bracket, and a spring disposed between the wheel and the first bracket.

4. A rotary kiln comprising a support member, a drum rotatably mounted to the support member at an incline to the horizontal, a brick liner disposed on the inner surface of the drum, a drive mechanism mounted to the support member and mechanically coupled to the drum including a motor, and a backstop mechanism coupled to the kiln to prevent rotation of the kiln in the reverse direction including a hollow member coupled to the kiln having a plurality of indentations at a common distance from the axis, the indentations having trailing edges forming an angle less than 45° with the radius from the axis of the member to the intersection of the trailing edge of the indentation and the outer edges of the member and leading edges forming an angle greater than 45° with the radius from the axis of the member to the intersection of the leading edge of the indentation and the outer edge of the member, a first angular bearing race mounted coaxially with the hollow member, a round bearing disposed adjacent to each indentation in the hollow member and rotatably mounted in the first race, a second bearing race mounted coaxially with the first race and abutting the bearings mounted in the first race, a brake shoe disposed about the second race and mounted to the support member, said shoe having spaced confronting ends, a layer of brake lining disposed between the brake shoe and the second race, a pair of brackets secured to the brake shoe adjacent to the ends thereof, the first of said brackets having a threaded aperture therein and the second bracket having an aperture, a shaft slidably disposed in the aperture in the second of the brackets and threadedly engaged in the aperture in the first bracket, a wheel secured to the shaft confronting the side of the first bracket opposite to the second bracket, and a spring disposed between the wheel and the first bracket.

References Cited in the file of this patent

UNITED STATES PATENTS

838,024	Hendricks	Dec. 11, 1906
1,645,554	Taylor	Oct. 18, 1927
1,903,070	Sahmel	Mar. 28, 1933
2,281,569	Fritsche	May 5, 1942
2,390,589	Holmes	Dec. 11, 1945
2,555,448	Koob	June 5, 1951
2,759,372	Hertrich	Aug. 21, 1956

FOREIGN PATENTS

474,922	Italy	Oct. 6, 1952