April 15, 1947. J. C. O'CONNOR 2,418,982

ROCKING MIXER

Filed June 9, 1944 3 Sheets-Sheet 1

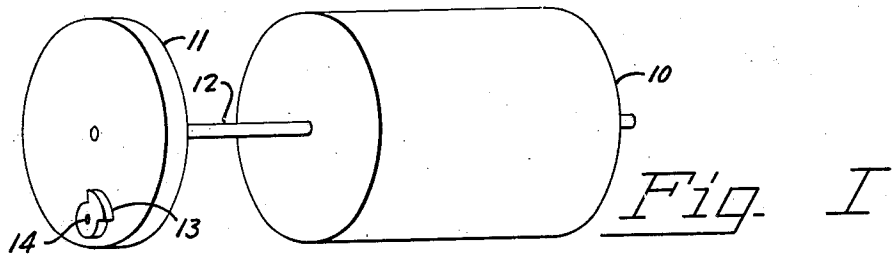


Fig. I

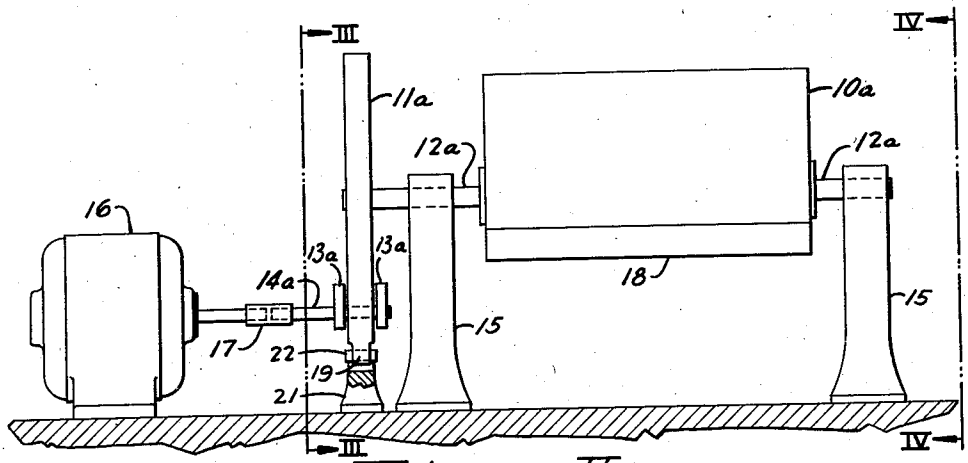


Fig. II

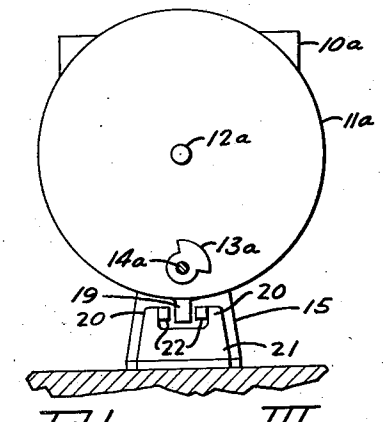


Fig. III

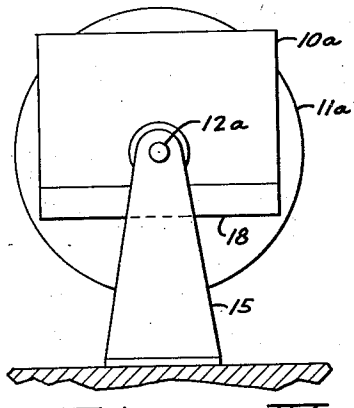


Fig. IV

INVENTOR.

John C. O'Connor

BY

Marshall & Marshall

ATTORNEYS

April 15, 1947. J. C. O'CONNOR 2,418,982

ROCKING MIXER

Filed June 9, 1944 3 Sheets-Sheet 2

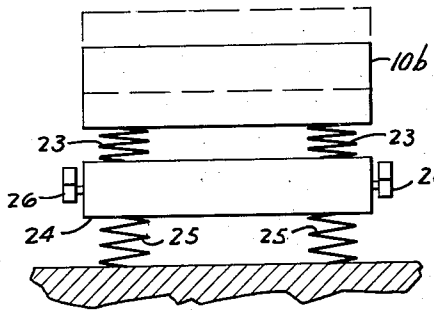


Fig. V

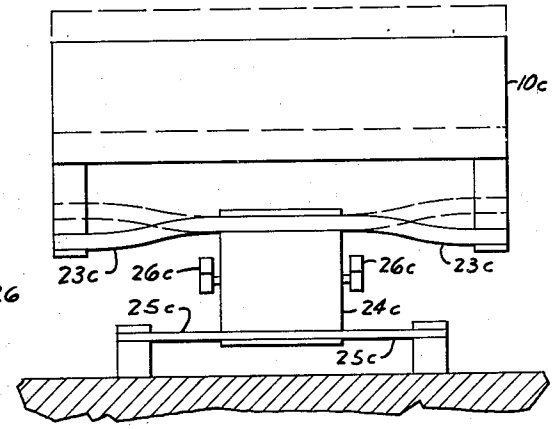


Fig. VI

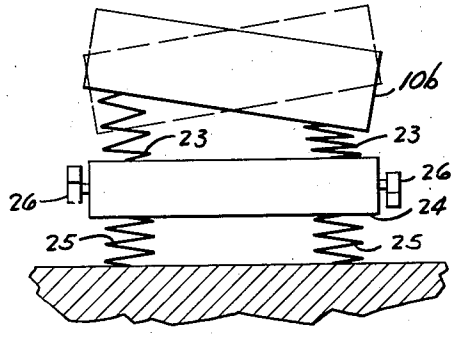


Fig. VII

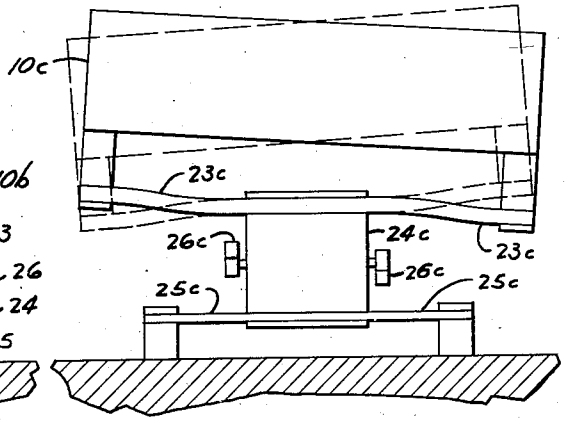


Fig. VIII

INVENTOR.
John C. O'Connor
BY
Marshall & Marshall
ATTORNEYS

April 15, 1947. J. C. O'CONNOR 2,418,982

ROCKING MIXER

Filed June 9, 1944 3 Sheets-Sheet 3

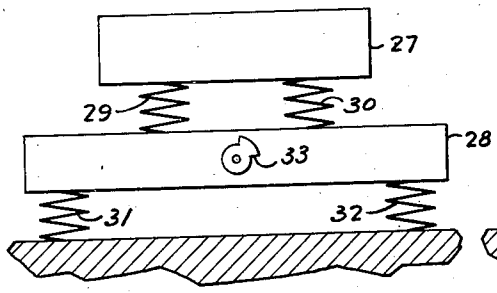


Fig. IX

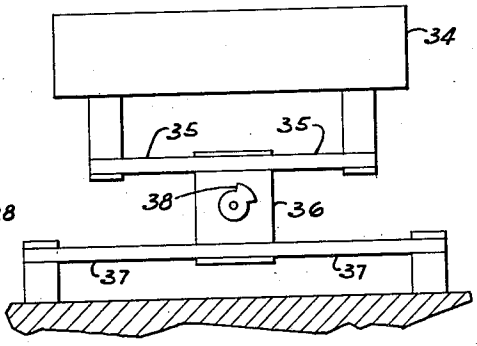


Fig. X

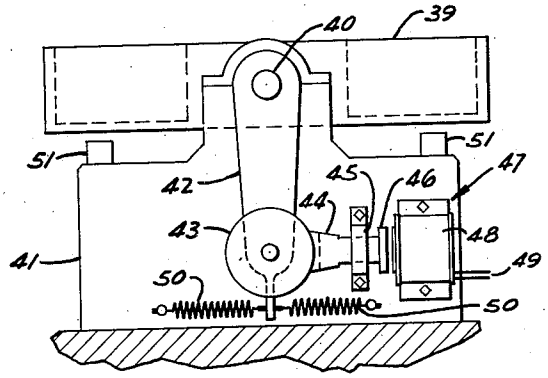


Fig. XI

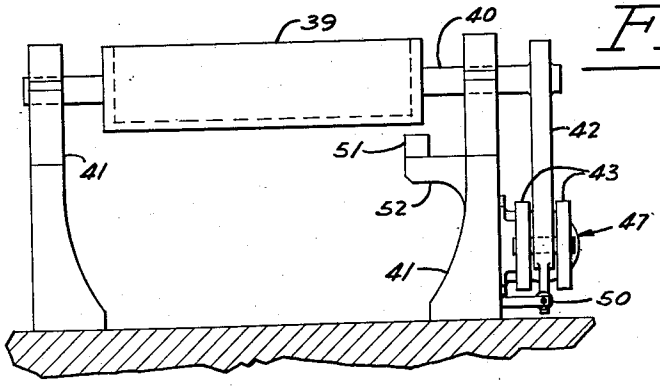


Fig. XII

INVENTOR.
John C. O'Connor
BY
Marshall & Marshall
ATTORNEYS

Patented Apr. 15, 1947

2,418,982

UNITED STATES PATENT OFFICE

2,418,982

ROCKING MIXER

John C. O'Connor, Dayton, Ohio

Application June 9, 1944, Serial No. 539,586

7 Claims. (Cl. 259—72)

1

This invention relates to apparatus for working on material by vibration and in particular to mixers employing a rocking motion wherein the motion is produced by vibratory forces applied to a member resiliently connected to the material contacting member.

In a copending application, which matured into United States Patent #2,353,492, vibratory apparatus was described in which a translatory vibration of the material contacting member is produced by a driving force applied to a portion of the system other than the material contacting member. That application also disclosed that a connected portion of the structure can be maintained substantially at rest while the material contacting member executed a translatory vibration.

In some applications it is desirable that the material contacting member execute a rocking motion rather than a translatory motion. This is particularly true when the objective is to produce the mixing of several ingredients without a conveying or a compacting action. In one form of the present invention the material contacting member is mounted on a torsionally resilient shaft and a force transmitting member incorporating a vibratory force generator is attached to the shaft in spaced relation to the material contacting member. The rocking motion in this example is about the shaft as an axis. In another form of the invention the material contacting member is mounted on a pair of springs in such manner that it may execute a rocking motion or a translatory motion or both, depending upon the frequency of the exciting force applied to it. This form is particularly advantageous in that either type of vibration is immediately available with no change other than the speed of the driving motor.

The principal object of the present invention is to produce a mixer adapted to work on material by a rocking vibration.

Another object is to provide a mixer for operating on material by vibration capable of either translatory vibration or rocking vibration wherein the type of vibration is selected by the frequency of the driving force.

Another object of the invention is to provide a mixer adapted to operate either by translatory vibration or by rocking vibration wherein the type of vibration is selected by the manner in which the driving force is applied.

Another object is to provide a mixer for operating on material by vibration in which the weight of the container and material is not supported on the resilient means determining the natural frequency of vibration.

2

These and other objects are apparent from the following description in which reference is made to the accompanying drawings.

In the drawings:

Figure I is a schematic illustration of a form of the invention showing a generalized material containing member connected to a force transmitting member by a torsionally resilient shaft.

Figure II is a simplified illustration of a practical form of the structure shown in Figure I.

Figure III is a vertical section taken along the line III—III of Figure II.

Figure IV is an end elevation taken along the line IV—IV of Figure III.

Figure V is a diagram of a second form of mixer.

Figure VI is an elevation of a simplified embodiment of the second form of mixer illustrating one mode of vibration.

Figures VII and VIII are similar to Figures V and VI and show another mode of vibration of the structure.

Figures IX and X show vibratory structures in which two modes of vibration may be independently excited and selected by speed change alone.

Figures XI and XII are end and side elevations of a rocking mixer employing an electromagnetic drive.

These specific drawings are intended to illustrate but not to define the scope of the invention.

In the first form of mixer as shown schematically in Figure I a cylindrical material container 10 and a disk-shaped force transmitting member 11 are mounted on a torsionally resilient shaft 12 in spaced relation with each other. An eccentric weight 13 is carried on a shaft 14 journaled in the force transmitting member 11 on an axis parallel to but spaced from the shaft 12. In this structure centrifugal force from rotation of the eccentric weight 13 produces a tangential component of force in the force transmitting member 11 causing it to vibrate torsionally. The vibration is transmitted through the shaft 12 to the material container 10 causing it to partake of the vibration. If the speed of rotation of the weight 13 is adjusted to the resonant frequency of the material container 10 on the resilient shaft 12 a vigorous torsional vibration is set up. The vibration is of such a character that the eccentric weight 13 and the vibratory system comprising the container 10 and the shaft 12 apply equal and opposite moments of force to the mem-

ber 11 with the result that it remains substantially quiescent. It is thus possible to produce a substantial torsional vibration without subjecting the bearings journaling the rotating shaft 14 to a destructive vibration.

A simplified version of a practical structure embodying the elements shown in Figure I comprises a generally rectangular material container 10a mounted on a torsionally resilient shaft 12a and a disk-shaped force transmitting member 11a in which is journaled a shaft 14a carrying eccentric weights 13a. The shaft 12a is preferably mounted in resilient bearings in pedestals 15. A motor 16 is connected through a flexible coupling 17 to drive the shaft 14a carrying the eccentric weights 13a. The container 10a is provided at its bottom with a counterweight 18 which is so proportioned that the center of gravity of the container and the counterweight lies approximately on the axis of the shaft 12a.

If the resilient bearings in the pedestals 15 freely allow substantial rotary motion of the shaft 12a the system tends to be unstable and to upset. This tendency to upset may be counteracted by locating one of the resilient bearings at the nodal point of the shaft 12a and causing that bearing to grip the shaft. Clamping in this manner has no more effect on the vibration than the holding of a tuning fork at the junction of the tines affects the tine vibration. The upsetting tendency may also be counteracted by providing the force transmitting member 11a with a depending ear 19 cooperating with upstanding lugs 20 of a stop 21 to limit the rotary movement of the vibratory system. The lugs 20 may be faced with resilient pads 22 of rubber or other suitable material to absorb the impact shock. If desired, metal springs could be substituted for the rubber pads.

In this structure the load placed in the container 10a is carried by shear and bending of the shaft 12a. This does not affect the torsional stress in the shaft and therefore does not interfere with the production of vibration.

In another type of rocking mixer a generally rectangular material container 10b is supported on a pair of springs 23 which in turn are connected to a base member 24 isolated from a foundation by springs 25. Rotating eccentric weights 26 are journaled in the base member 24 to provide the vibratory driving force.

Figure VI shows a simplified structure similar to that shown schematically in Figure V. In this structure a material container 10c is supported on cantilever springs 23c attached to a base member 24c. The base member is supported on a resilient beam 25c. Eccentric weights 26c supply the vibratory energy to maintain the container in vibration. If the system is symmetrical, i. e. if the springs 23c are of equal strength, the center of gravity of the container 10c is at its geometrical center, and the eccentric weights 26c are in phase, the vibration indicated by the dotted lines in Figure VI is produced.

The structures shown in Figures V and VI are also capable of a rocking vibration. The easiest way to excite this rocking motion is to displace one of the eccentric weights 26c 180° with respect to the other so that these weights apply a moment force to the base 24c rather than a translatory force. The natural frequency of this mode of vibration is, in general, different from the natural frequency of the structure when executing a translatory vibration. The natural frequency of the translatory vibration depends upon the weight of the container and the stiffness of the springs. The natural frequency of the rocking motion depends upon the moment of inertia of the container about the rocking axis and the stiffness of the springs in resisting the rocking motion. It is thus apparent that only by special design may the two frequencies be made equal. If they are made equal the mode of vibration may be selected by merely changing the phase of one of the unbalanced weights with respect to the other while if they are not equal it is generally necessary to change both the phase of the weights and the speed of the driving motor.

In either case the reaction on the base 24 or 24c of the vibration of the material contacting member 10b or 10c is in such direction as to counterbalance the force of the rotating unbalanced weights so that the base member 24c remains substantially quiescent and transmits little or no vibratory force through the springs 25 or 25c to the foundation.

If the rotating shaft carrying the unbalanced weights be shifted about a vertical axis through an angle of 90°, such that it is perpendicular to the length of the cantilever springs rather than parallel to them, the rocking motion may be produced without changing the phase of the unbalanced weights. The structures so modified are shown in Figures IX and X. In Figure IX a material container 27 is shown supported from a base 28 by resilient springs 29 and 30. Another pair of springs 31 and 32 support the base member 28. Rotating eccentric weights 33 journaled in the base member 28 provide the source of vibratory power.

If the resultant of the force of the springs 29 and 30 does not pass through the center of gravity of the container 27 or if the spring rate of the springs 29 and 30 are not equal either mode of vibration, i. e. a rocking mode or straight line mode, may be produced by rotation of the eccentric weight 33. In general these two modes of vibration have widely different frequencies and may therefore be selected by adjustment of the speed of rotation of the unbalanced weight 33.

In this case in which the system is not symmetrical neither type of vibration may be produced entirely independent of the other. The motion of the container 27 consists of a rocking motion and a translatory motion. At one frequency the axis about which the container rocks is near the center of gravity of the container while at the other frequency the center of oscillation is about a point outside and at some distance from a container. Thus the first mode of vibration consists chiefly of a rocking motion and the second mode consists chiefly of a translatory motion. The degree to which these motions may be separated is determined by the symmetry and damping of the structure; the greater the symmetry and the less the damping the greater the independence between the modes of vibration. In fact, if the system be made exactly symmetrical the rocking mode of vibration may be somewhat difficult to produce in the absence of a component of driving force acting eccentrically upon the vibrated member.

In the practical application of this principle, as shown schematically in Figure X, a material container 34 is supported on the ends of cantilever springs 35 extending from a base member 36. The base member 36 is resiliently supported from the foundation by springs 37. A rotating eccentric weight 38 which may be driven by a two-speed electric motor is journaled in the base member 36. This structure is capable of vibrating in

either of the modes shown in Figures VI or VIII. The natural frequency of the container **34** on the springs **35** for the mode of vibration illustrated in Figure VI, the translatory vibration, is made equal to the higher speed of the motor driving the weight **38**. The other mode of vibration, the rocking mode, is made equal to the lower speed of the motor. In this case even though the system is symmetrical either type of vibration may be selected and produced by a mere speed change of the motor. The translatory vibration at the higher speed is produced largely by the vertical component of the centrifugal force produced by the rotating eccentric weight while the rocking motion is produced largely by the horizontal component. The production of the rocking motion is facilitated in the structure shown in Figure X by the fact that the springs **35** and the base **36** are located a substantial distance below the center of mass of the container **34** and the horizontal component of force is transmitted along their lengths rather than transversely thereto.

Other power sources besides a rotating weight may be used to excite a rocking mixer. An example of another kind of power source is a straight-line electric motor which consists essentially of a solenoid acting on an armature. Such a motor may be advantageously used with the rocking mixer by arranging it so that it applies a moment force to either the material container or the force transmitting member. In any case a vibratory system comprising a resilient shaft with a substantial mass at each end, one of which is a material container, is used. The mass other than the material container supplies the means to store the reactive energy of the vibratory system. The power to maintain the vibration may be applied to either member.

In the preceding examples the power was applied to a force transmitting member by means of a rotating weight. Figures XI and XII show a similar rocking mixer in which power from a straight-line electromagnetic motor is applied to the force transmitting member. In this example a material container **39** is supported on a transverse resilient shaft **40** which is journaled in pedestals **41**. An arm **42** secured to one end of the shaft **40** acts as the force transmitting member. The arm **42** extends downwardly from the shaft **40** and at its lower end pivotally carries a substantial mass **43** forming one end of a horizontal connecting rod **44**. The connecting rod **44** passes through a guide **45** and at its end carries an armature **46** comprising the moving part of an electromagnetic straight-line motor **47**. The stationary part of the motor **47** including its coil **48** is mounted on one of the pedestals **41**. Leads **49** connect the coil **48** to a suitable power source.

If the weight of the mass **43** forming the end of the connecting rod **44** is insufficient to maintain the container **39** upright and the armature **46** in operative position with respect to the remainder of the motor **47**, a pair of springs **50** may be attached from the lower extremity of the arm **42** to the foundation to ensure stability. The springs **50** are of sufficiently low rate that they do not materially affect the production of or the frequency of the vibration of the container which is excited by the straight-line motor **47**.

Resilient stops **51** made of rubber or other suitable material mounted on arms **52** extending from one of the pedestals **41** are provided to limit the maximum vibration of the material container **39**.

In the operation of such a structure the arm **42** including the mass **43** acts as one of the masses of a two-mass single-spring vibratory system. The shaft **40** provides the spring and the material container **39** provides the other mass. The two masses vibrate in opposite phase, i. e. against each other thus torsionally stressing the shaft **40**. The force from the straight-line motor **47** supplies the losses of the system but does not materially affect its frequency.

These examples illustrate simple structures which with a minimum of parts allow the advantages of both rocking and translatory or reciprocal vibration to be attained. These structures are adapted for use in the mixing and packaging of various materials. For example the ingredients of a batch may be placed in the container, the motor brought up to its lower speed, and the material mixed by the ensuing rocking motion of the container. After the material has been sufficiently mixed the motor may be brought up to its higher speed thus producing a translatory vibration to compact the material.

In other applications, for example in the mixing of paints, it is an advantage to have both types of vibration instantly available.

The foregoing illustrations and descriptions should be construed as merely illustrating structures by which the invention may be realized.

Having described my invention, I claim:

1. In a device of the class described, in combination, a torsionally resilient shaft, a material contacting member secured to said shaft, a force transmitting member secured to said shaft in spaced relation to said material contacting member, an eccentrically loaded shaft journaled in said force transmitting member remote from said shaft, and means for rotating said eccentrically loaded shaft.

2. In a device for working on material by vibration, in combination, a torsionally resilient shaft, a material containing member secured to said shaft, a force transmitting member secured to said shaft in spaced relation to said material containing member, and means employing a cyclically moving mass journaled in said force transmitting member for impressing a cyclical force having tangential component to said force transmitting member, said material containing member, said force transmitting member and said shaft forming a vibratory system in which torsional vibration is induced by said cyclical force.

3. In a device of the class described, in combination, a torque transmitting member, a material contacting member, resilient means for supporting said members and resisting relative angular movement therebetween, a cyclically moving mass carried on said torque transmitting member, said mass by its motion applying to the torque transmitting member a torque that is generally equal and opposite to the torque exerted by relative angular movement between the members as transmitted through the resilient means.

4. In a device of the class described, in combination, a force transmitting member, a material contacting member, resilient means for supporting said members and resisting relative angular movement and translation therebetween, a weight carried eccentrically on a shaft journaled in the force transmitting member for applying force to the force transmitting member, and means for rotating the shaft at selected speeds that include the resonant frequency of translatory vibration of the material contacting mem-

ber on the resilient means and the resonant frequency of torsional vibration of the material contacting member on the resilient means.

5. In a device for working on material by torsional vibration, in combination, a material contacting member, a force transmitting member, a torsionally resilient shaft supporting said members and resisting relative angular movement therebetween, a cyclically moving mass carried on the force transmitting member, the inertia forces of the moving mass applying torque to the force transmitting member, and means for driving the mass at a frequency equal to the resonant frequency of the material contacting member and the resilient shaft.

6. In a device for working on material by torsional vibration, in combination, a material contacting member and a force transmitting member of generally equal moments of inertia, resilient means for supporting said members and resisting relative angular movement therebetween, a shaft carrying an eccentric weight journaled in the force transmitting member for applying torque forces to the force transmitting member, and means for rotating the shaft at a frequency generally equal to the resonant frequency of the system comprising the material contacting member and the resilient means connecting it to the force transmitting member.

7. In a device of the class described, in combination, a force transmitting member, a material contacting member, resilient means for supporting said members and resisting relative angular movement and translation therebetween, a cyclically moving mass carried on said force transmitting member for applying force to the force transmitting member, and means for cyclically moving the mass at selected frequencies that include the resonant frequency of translatory vibration of the material contacting member on the resilient means and the resonant frequency of torsional vibration of the material contacting member on the resilient means.

JOHN C. O'CONNOR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,353,492	O'Connor	July 11, 1944
2,144,046	Cundall	Jan. 17, 1939
1,392,345	Lowe	Oct. 4, 1921
1,774,705	Forsberg	Sept. 2, 1930

FOREIGN PATENTS

Number	Country	Date
678,302	French	Dec. 23, 1929