

June 9, 1953

E. FOUQUET

2,641,089

METHOD AND MEANS FOR THE REPRODUCTION BY GRINDING

Filed Aug. 28, 1951

2 Sheets-Sheet 1

Fig. 1

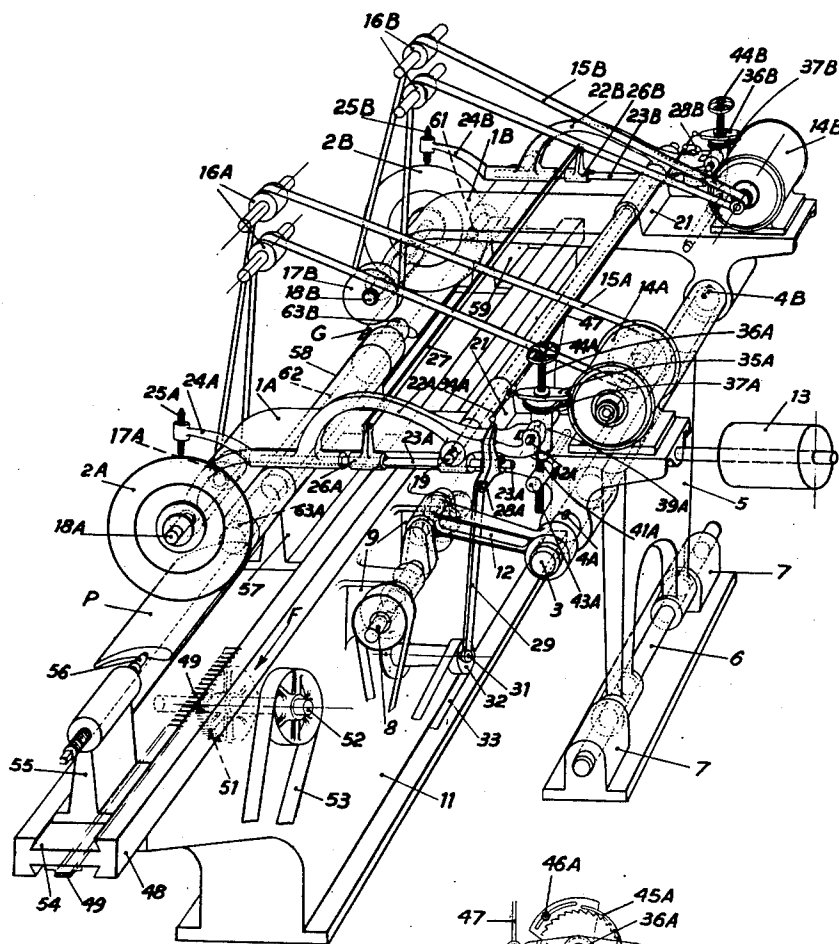
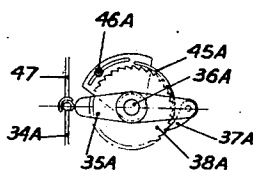


Fig. 2



Inventor
Eugene Fouquet
By Robert E. Burns
Attorney

June 9, 1953

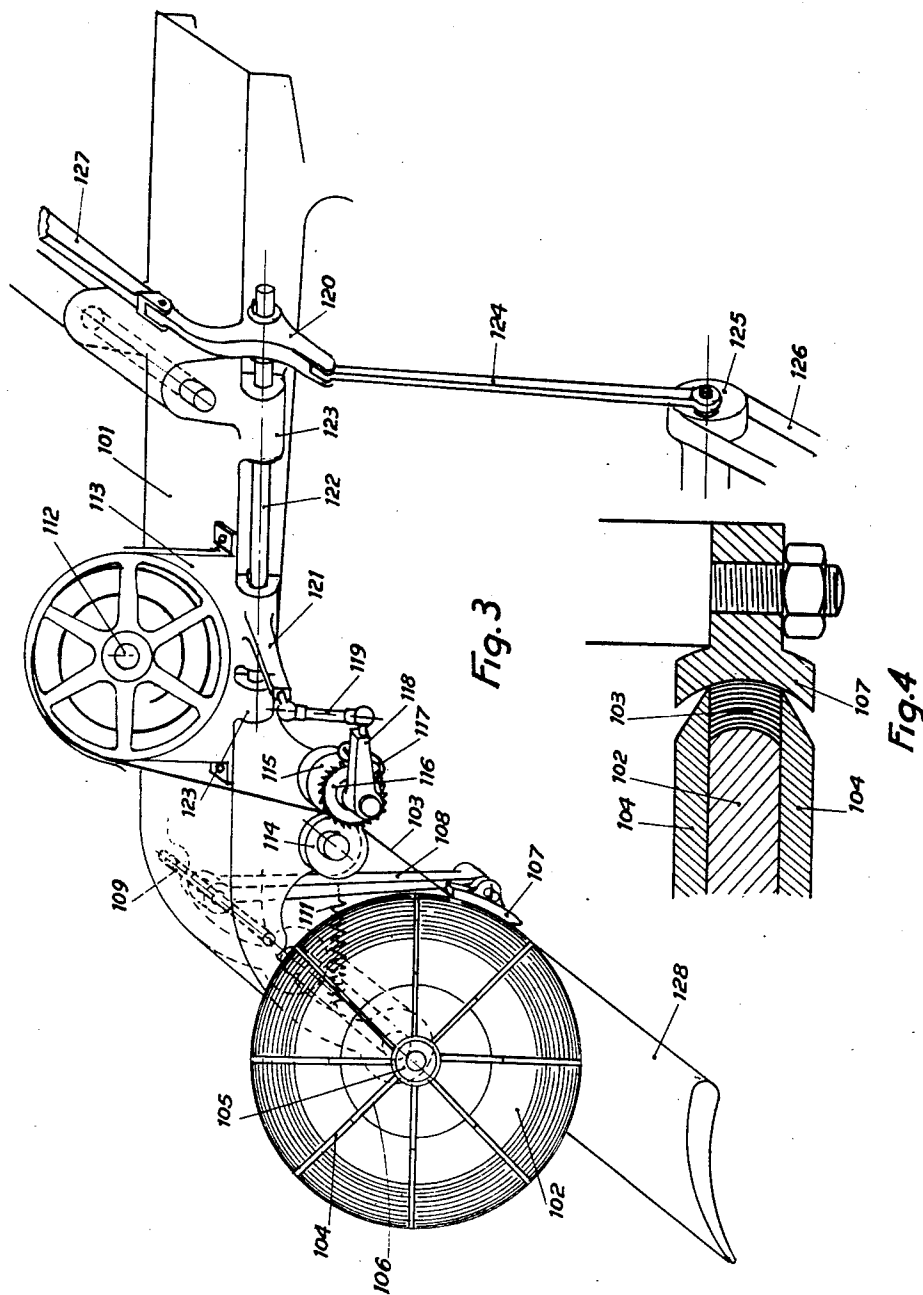
E. FOUQUET

2,641,089

METHOD AND MEANS FOR THE REPRODUCTION BY GRINDING

Filed Aug. 28, 1951

2 Sheets-Sheet 2



Inventor
Eugene Fouquet
By *Robert E. Burns*
Attorney

UNITED STATES PATENT OFFICE

2,641,089

METHOD AND MEANS FOR THE REPRODUCTION BY GRINDING

Eugène Fouquet, Bois-Colombes, France

Application August 28, 1951, Serial No. 244,060
In France July 24, 1951

11 Claims. (Cl. 51-101)

1

The present invention relates to methods and means for the reproduction, by grinding, from a pattern in rolling contact with a touching wheel adapted to follow the contour of this pattern and to transmit its movements to a grinding wheel that operates on the work-piece intended to be reproduced.

The method according to the present invention consists essentially in employing a grinding wheel and a touching wheel of equal diameters and imparting, during the entire period of machining, equal diameter reductions to both the grinding wheel and the touching wheel.

It is of advantage that the diameter reductions, imparted to both the grinding wheel and the touching wheel, are slightly superior to those produced on the grinding wheel by its natural wear at the contact with the work-piece being machined thereby. In this way the equality of diameter of the touching and grinding wheels can be thoroughly ensured.

The concomitant reductions in diameter of the grinding and touching wheels may be ensured by causing appropriate tools to act upon these wheels. These tools may be of any kind. The operation may be effected for example by means of "crushing" wheels or by means of diamonds, or the like. When the operation is effected by means of diamonds, it is of advantage to impart to the tools, in addition to the radial displacements determining the reduction of diameter of the grinding and touching wheels, transversal displacements, along a circular arc, that constantly ensure a correct profiling of these wheels.

If use is made of a touching wheel on which the reductions in diameter are effected by means of a tool, it is of advantage to make this wheel from a material analogous to the binders employed for binding abrasive grains of a grinding wheel, but without abrasive grains; this touching wheel must be such that it may be attacked by the diameter reducing tool at the speeds with which it rotates, but that it is not enough hard to wear out the pattern with which it cooperates.

But there may also be employed a touching wheel constituted by a reel of metal band whose outer surface cooperates with the pattern, the reduction in diameter of this wheel being determined by an unwinding of the band, in dependence with the reduction in diameter of the grinding wheel.

Two forms of apparatus suitable for carrying the invention into practical effect will now be described, by way of example, with reference to the accompanying drawings in which:

2

Fig. 1 is a perspective view of a machine intended for the reproduction by grinding and comprising the various improvements according to the present invention, the touching wheel being attacked by tool.

Fig. 2 is a plan view of a detail thereof.

Fig. 3 is a part view of a machine comprising a touching wheel constituted by a reel of metal band; and

Fig. 4 shows in section a detail thereof.

The machine shown in Fig. 1 has an oscillating frame comprising essentially a grinding wheel carrying arm 1A and a touching wheel carrying arm 1B, that carry the grinding wheel 2A and the touching wheel 2B, respectively. These arms are mounted on a common shaft 3 where they are made rigid for example by means of keys 4A and 4B. On the other hand, the shaft 3 is mounted in an oscillating support 5 adapted to oscillate, through the intermediary of a shaft 6, in the fixed bearing 7 of the general framework of the machine. The support 5 and, consequently, the whole oscillating assembly receive their motion from a crank-shaft 8 mounted in fixed bearings 9 rigid with the frame 11 of the machine, through the intermediary of a connecting rod 12 that drives the shaft 3. A counterweight 13 balances the overhanging mass of the oscillating frame.

The grinding wheel 2A receives its motion from a motor 14A secured to the oscillating frame, through the intermediary of a belt 15A which passes around transmission pulleys 16A mounted on the oscillating frame and which rotates a pulley 17A keyed to the shaft 18A driving the grinding wheel 2A. The touching wheel 2B is rotated, in the similar way but, in principle, with reduced speed, by a motor 14B and through a transmission whose parts have the same numerals of reference as the parts that control the grinding wheel 2A but are provided with the index B.

There will now be described the parts which, mounted on the oscillating frame, ensure the diamonding of the grinding wheel 2A and that of the touching wheel 2B. The diamonds must execute simultaneously a downward displacement, by which they are caused to move toward the centers of the grinding and touching wheels, respectively, and a transversal oscillating displacement, perpendicular to the plane of the paper, to ensure constantly a correct profiling of the grinding wheel and that of the touching wheel. Moreover, the displacements of the diamonds must be strictly identical on the grinding wheel and on the touching wheel.

3

On a shaft 19, mounted to rotate in bearings 21 secured to the oscillating frame, there are keyed arcuate arms 22A, 22B that form bearings in which may rotate shafts 23A, 23B rigid with incurred parts 24A, 24B into which are screwed the diamond carriers 25A, 25B having on their ends the diamonds. It is clear that, with the shafts 23A, 23B oscillating about their axes, the diamonds describe, reciprocatingly, about the same axes, arcs whose centers are located on these axes.

The shafts 23A, 23B are interconnected, through the intermediary of T-like sleeves 26A, 26B secured thereto, by means of a connecting rod 27.

The shafts 23A, 23B are caused to oscillate by two-arm levers 28A, 28B keyed thereto. One arm of the lever 28A is actuated by a connecting rod 29 pivotally connected with an eccentric pin 31 secured to a pulley 32 rotatable, through the intermediary of a belt 33, by means of a motor not shown. The other arm of lever 28A is pivotally connected, through a ball-joint, to one end of a rod 34A in turn pivotally connected, through a ball-joint, at the other end to a pawl carrier 35A (Fig. 2) adapted to oscillate about a rod 36A and carrying a pawl 37A engaged into the teeth of a ratchet 38A, the engagement being ensured by a spring not shown. This ratchet 38A is rigid with an inner threaded sleeve 39A cooperating with threads of the rod 36A. A nut 41A, engaged onto threads of the sleeve 39A, serves to hold the sleeve 39A axially. An axle 42A serves for pivoting the tail of the arcuate part 22A pivoted at 19. On the other hand, the threads of rod 36A are screwed into a pivoting nut 43A mounted rotatably in the oscillating frame. A hand wheel 44A, keyed to the threaded rod 36A, serves for preliminary adjustment. It is clear that when, because of the reciprocating rotation of the shaft 23A, the ratchet 38A, actuated by the pawl 37A, rotates always in the same direction, it determines, through the intermediary of the threaded sleeve 39A, an ascent of the tail of part 22A and hence a descent of the diamond carrier 25A.

In order to regulate the magnitude of this descent, use may be made, as is well known in mechanics, of a tooth-mask 45A (Fig. 2) displaceable by means of a button 46A engaged into an arcuate slot. According to the position of the end of this tooth-mask, the point of pawl 37A, in its active course, will advance the ratchet through one tooth or through two teeth, and so on as may be desired.

A connecting rod 47 connects, through ball-joints, the pawl-carriers 35A, 35B in such a way that their angular displacements be identical.

Finally, in order to support the pattern and the work-piece and to displace them transversally in respect to the grinding and touching wheels, use is made of a table 48 guided by a dovetailed slide upon a bench of the general frame 11 of the machine. The displacement of the table is effected by means of a rack 49 rigid with the table and meshing with a pinion 51 keyed to a shaft 52 rotatable by a belt 53 from a motor not shown. The table 48 has its upper portion formed to a dovetailed slide 54 in which may be displaced or fixed by appropriate means, for example screws, a support 55 of the point 56, a support 57 of headstock 58, and a support 59 of the counterpoint 61.

The grinding wheel 2A is an abrasive wheel and the touching wheel is a disc made of a ma-

4

terial which is hard enough to roll on the pattern without crumbling and wearing out, but which is not susceptible of wearing out the pattern. Preferably, use will be made of a product analogous to that which serves as binder for the abrasive of the grinding wheel.

The operation of the machine is as follows:

At first, there are placed in the machine the pattern G, intended to be reproduced exactly, and the raw piece P intended to be brought exactly to the form of the pattern G. To this end, there are introduced into the ends of the sleeve 58, that constitutes the headstock and contains a bracing shaft 62, the tails or appendages 63A, 63B with which are provided both the pattern G and the raw piece P. The assembly is then jammed between the point 56 and the counterpoint 61, after the reciprocal orientation of the pattern G and the piece P have been determined and after this orientation has been fixed by means of screws not shown.

The table 48 is then brought to a position such that the grinding wheel 2A slightly overlaps forwardly (Fig. 1) the piece P whose overthickness will have to be cleared away so as to bring it to exact dimensions of the pattern G, while the touching wheel 2B rests on the pattern G. Then, by acting upon the hand wheel 44A, the grinding wheel 2A is lowered in respect to the touching wheel 2B, and this lowering corresponds to the overthickness to be cleared away.

The machine is then set in operation. Under the action of the rack 49 controlled by the pinion 51 and the belt 53, the table 48 moves in the direction of the arrow F, so that the grinding wheel 2A, rotating with high speed, and the touching wheel 2B, rotating with lesser speed, move along the piece P and the pattern G, respectively. At the same time, under the action of the shaft 8, the oscillating frame, constituted by the support 5, grinding wheel carrier 1A and touching wheel carrier 1B, describes a reciprocating oscillation about the shaft 6, so that the grinding wheel 2A and the touching wheel 2B move transversally of the pattern G and the piece P.

Also at the same time, under the action of the pulley 32, the shafts 23A, 23B execute their reciprocating oscillation about their axes, so that the diamonds mounted on the diamond carriers 25A, 25B accomplish a reciprocating oscillation along an arc whose plane is transversal with respect to the planes of the grinding wheel 2A and the touching wheel 2B, in a manner to ensure the correct contour of this grinding wheel and of this touching wheel. This oscillating motion is accompanied, owing to the pawl-carriers 35A, 35B and to the pawls 37A, 37B, by the rotation, always in the same direction, of the ratchets 38A, 38B which determine the progressive descent of the diamonds which, by acting simultaneously upon the grinding and touching wheels, ensure the synchronous reduction of the diameters of both the grinding wheel 2A and the touching wheel 2B.

When its upper face is thus machined, the piece P and the pattern G are turned over in the headstock and similar operation takes place for the lower face. It is clear that if it be desired to reproduce pieces having more than two opposed faces, there may be provided on the headstock a mechanism suitable for turning, in a continuous or discontinuous way, both the pattern and the piece to be reproduced.

In the form of apparatus shown in Figs. 3 and 4, there is employed, in lieu of a touching wheel

5

worn out by diamond, a touching wheel onto which is wound a band, preferably metallic, whose turns are unwound, subjected to braking, in a manner to reduce the diameter of the touching wheel, in dependence with the wear of the grinding wheel. In Fig. 3 there is only shown the portion of apparatus comprising the touching wheel; the portion comprising the grinding wheel is to be imagined in conjunction with Fig. 1.

The touching wheel, supported by its arm 101, comprises a core 102 keyed to a shaft 105 and onto which is wound preferably metallic a band 103. This band is retained laterally by means of spokes slidably displaceable in grooves 106, managed in the core, as the band is being unwound, in a manner to retain the same laterally. The band is pressed against the touching wheel by a brake block 107 pivoted to an arm 108 pivotally mounted on an axle 109 supported on the touching wheel carrier 101, and urged toward the center of this wheel by a spring 111. The band 103 comes to wind onto a spindle 112 mounted on bearings 113 supported on the touching wheel carrier 101, when this band is displaced by the mechanism which will be described hereafter.

Between the touching wheel and the spindle 112 the band 103 passes between two rollers 114, 115 at least one of which, say 114, has a compressed rubber rim, the roller 115 rotatable jointly with a ratchet 116 that cooperates with a pawl 117 pivoted to a reciprocating lever 118. A tooth-mask system, such as that described in conjunction with Figs. 1 and 2, permits of regulating the amplitude of the rotation of ratchet 116.

The lever 118 receives a reciprocating motion from a connecting rod 119 mounted on ball-joints and actuated by an arm 121 rigid with a sleeve keyed to a shaft 122 mounted to rotate in bearings 123 rigid with the touch wheel carrier 101. Also keyed to the shaft 122 is a two-arm lever 120 one arm of which is pivoted to one end of a connecting rod 124 the other end of which is pivoted to the eccentric pin of a pulley 125 rotatable, through the intermediary of a belt 126, by a motor not shown. A bar 127, pivotally connected with the other arm of 120, serves to synchronize the system, like in Fig. 1, with the means for controlling the diamond that acts upon the grinding wheel.

The operation is as follows:

The touch wheel rests on the pattern 128, which has been oiled, and slides on it. As the grinding wheel is being worn out under the action of the diamond attacking this wheel, the ratchet 116, rotating under the effect produced by the oscillation of the shaft 122 about its axis, rotates the roller 115 so that the band 103, jammed between this roller and the rubber-lined roller 114, is unwound from the core 102 and wound onto the spindle 112. It results therefrom that the touch wheel decreases in diameter.

It is of advantage to employ a magnetized band, since the adherence imparted by the magnetization to the turns of winding prevents spontaneous unwinding.

It is also of advantage (Fig. 4) to employ, instead of a flat band, a bulged band the bulge radius of which may be preferably the same as that of the reciprocating transversal motion of the diamond in respect to the grinding wheel. In this way, the reproduction does not undergo any deformation. Furthermore, this form of

6

band is of much better comportment than the flat band.

What is claimed is:

1. In the method of reproduction by grinding by means of a follower roll continuously following a pattern and a grinding wheel, simultaneously and continuously machining a work piece and gradually becoming reduced in diameter, said follower roll and said grinding wheel having equal diameters and similar working profiles, the improvement which comprises continuously and automatically effecting, during the machining of the work piece by the grinding wheel and in synchronism with the reduction in diameter of said grinding wheel, equal reductions in the diameter of said follower roll, while maintaining similar working profiles on said grinding wheel and said follower roll.

2. In the method of reproduction by grinding by means of a follower roll continuously following a pattern and a grinding wheel simultaneously and continuously machining a work piece and gradually becoming reduced in diameter, said follower roll and said grinding wheel having equal diameters and similar working profiles, the improvement which comprises continuously and automatically effecting, during the machining of the work piece by said grinding wheel, reductions in the diameters of said grinding wheel and said follower roll which are greater than the diameter reductions which would be produced by the natural wear of said grinding wheel acting upon said work piece, while maintaining similar working profiles on said grinding wheel and said follower roll.

3. A machine for reproduction by grinding comprising, in combination, a fixed standard adapted to carry a work piece, a pattern mounted on said standard, a frame movably mounted on said standard, a follower roll mounted on said frame and engaging said pattern, a rotating grinding wheel mounted on said frame coaxially to said follower roll and machining said work piece, said follower roll and said grinding wheel having equal diameters, and means mounted on said frame and acting in synchronism with the reduction of diameter of said grinding wheel during grinding of said work piece and adapted to reduce correspondingly and equally the diameter of said follower roll.

4. A machine for the reproduction by grinding comprising, in combination, a fixed standard adapted to carry a work piece, a pattern mounted on said standard, a frame movably mounted on said standard, a rotating follower roll mounted on said frame and engaging said pattern, a rotating grinding wheel mounted on said frame coaxially to said follower roll and machining said work piece, said follower roll and said grinding wheel having equal diameters, trimming tools mounted on said frame cooperating with said grinding wheel and movable in a plane perpendicular to said roll and to said wheel along a circular path, means mounted on said frame and acting in synchronism with the reduction of diameter of said grinding wheel, said means adapted to reduce correspondingly and equally the diameter of said follower roll, and control means mounted on said frame to impart to the tools an oscillating displacement.

5. A machine for the reproduction by grinding comprising, in combination, a fixed standard adapted to carry a work piece, a shaft mounted in said standard, a pattern mounted on said standard, a frame mounted on said shaft and

7

adapted to tilt around the axis of said shaft, a follower roll mounted on said frame and engaging said pattern, a grinding wheel mounted on said frame coaxially to said follower roll and machining said work piece, said follower roll and said grinding wheels having equal diameters, the common axis of the follower roll and of the grinding wheel being parallel to said shaft, and control means mounted in said frame to impart a rotating motion to said follower roll and to said grinding wheel.

6. A machine for the reproduction by grinding comprising, in combination, a fixed standard adapted to carry a work piece, a shaft mounted in said standard, a pattern mounted on said standard, a frame mounted on said standard and adapted to tilt around the axis of said shaft, a rotating follower roll mounted on said frame and engaging said pattern, a rotating grinding wheel mounted on said frame coaxially to said follower roll and machining said work piece, said follower roll and said grinding wheels having equal diameters, the common axis of the follower roll and of the grinding wheel being parallel to said shaft, a second frame tiltably mounted with relation to said first frame on an axis parallel to the axis of said shaft, two rods mounted in said second frame transversely with relation to said shaft and adapted to oscillate about their axes, trimming tools eccentrically carried by said rods and cooperating respectively with said follower roll and with said grinding wheel, control means mounted on said rods to impart an oscillating movement to said rods, and a transforming mechanism actuated by said oscillating movement and acting in a continuous manner on said second frame to displace the tools radially with relation to the axes of said follower roll and of said grinding wheel.

7. A machine as defined in claim 3 wherein

8

the follower roll is formed by a binder similar to that of the grinding wheel, but without abrasive grains.

8. A machine for the reproduction by grinding comprising, in combination, a fixed standard adapted to carry a work piece, a pattern mounted on said standard, a frame movably mounted on said standard, a rotating grinding wheel mounted on said frame and machining said work piece, a roll formed by a metallic band acting as follower roll, the overall diameter of said roll being equal to the diameter of the grinding wheel and said roll being mounted coaxially to said grinding wheel and in engagement with said pattern, and means mounted on the frame for unwinding said metal band in synchronism with the reduction of diameter of said grinding wheel.

9. A machine as defined in claim 8, further comprising a plurality of driven rollers arranged to control the unwinding of said metal band.

10. A machine as defined in claim 8, wherein said metal band is magnetized.

11. A machine as defined in claim 8, wherein the metal band is transversely bulged and the bulge radius is substantially equal to the profiling radius of the grinding wheel.

EUGÈNE FOUQUET.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,769,143	Koskinen	July 1, 1930
2,365,302	Shutt et al.	Dec. 19, 1944
2,388,172	Michailoff	Oct. 30, 1945
2,499,655	Laurent	Mar. 7, 1950

FOREIGN PATENTS

Number	Country	Date
622,951	Great Britain	May 10, 1949