

Sept. 30, 1947.

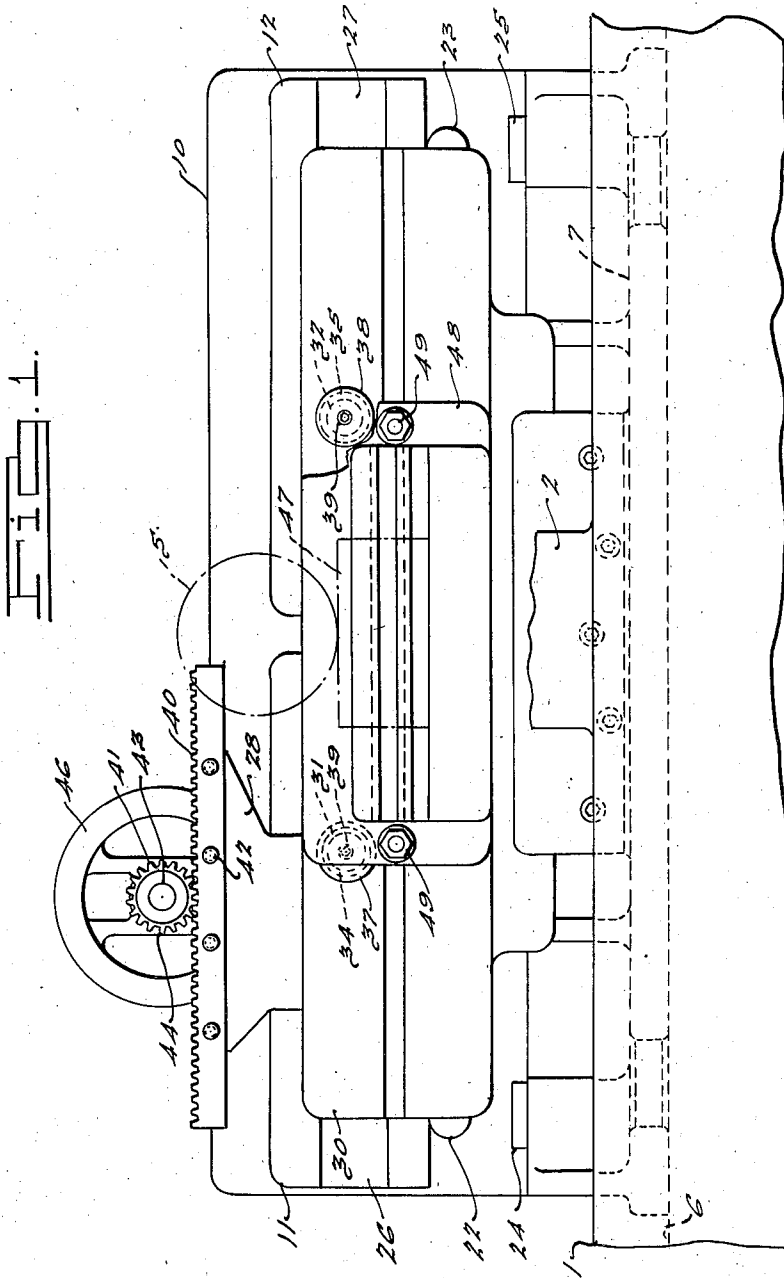
C. E. HALL

2,428,215

MACHINE FOR GRINDING LONG RADIUS ARCS

Filed Oct. 29, 1945

3 Sheets-Sheet 1



INVENTOR.

Calvin E. Hall.

BY

Hanness, Dickey & Pierce.

ATTORNEYS.

Sept. 30, 1947.

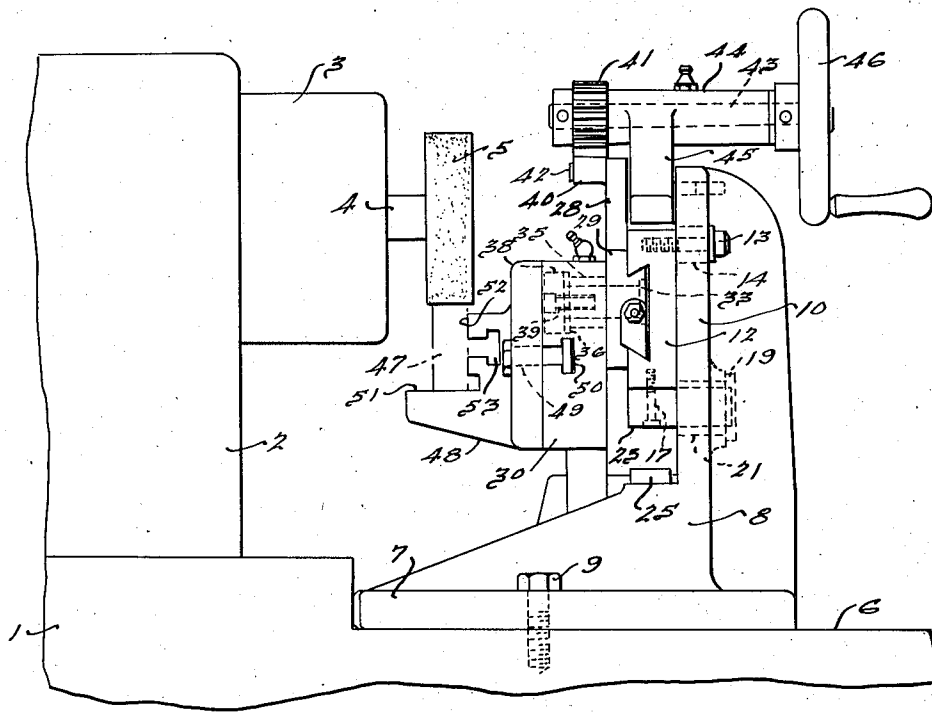
C. E. HALL

2,428,215

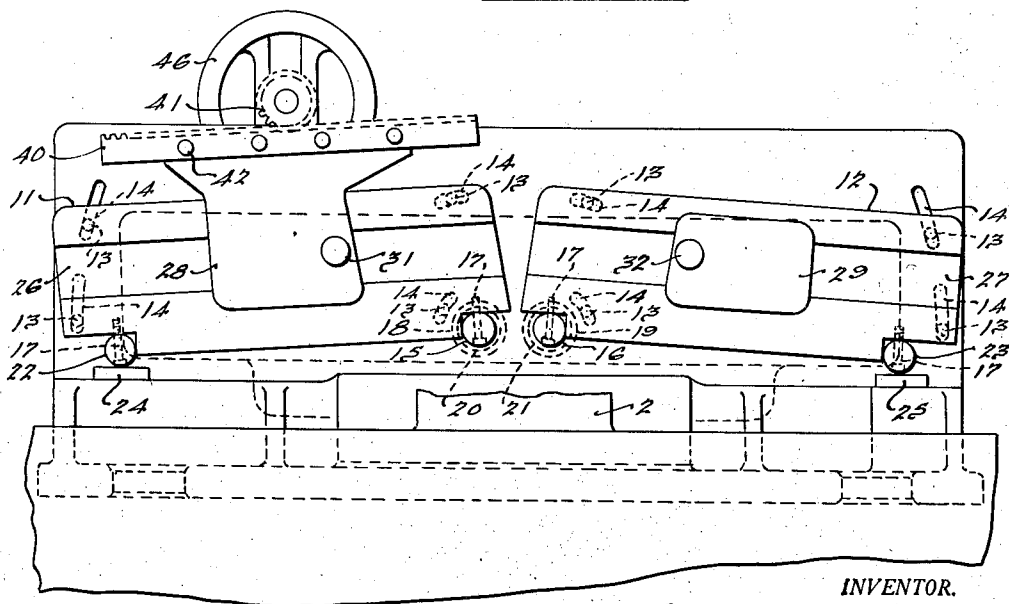
MACHINE FOR GRINDING LONG RADIUS ARCS

Filed Oct. 29, 1945

3 Sheets-Sheet 2



II. 2.



File 3.

INVENTOR.

Calvin E. Hall.

BY

Harness, Dickey & Pierce.

ATTORNEYS.

Sept. 30, 1947.

C. E. HALL

2,428,215

MACHINE FOR GRINDING LONG RADIUS ARCS

Filed Oct. 29, 1945

3 Sheets-Sheet 3

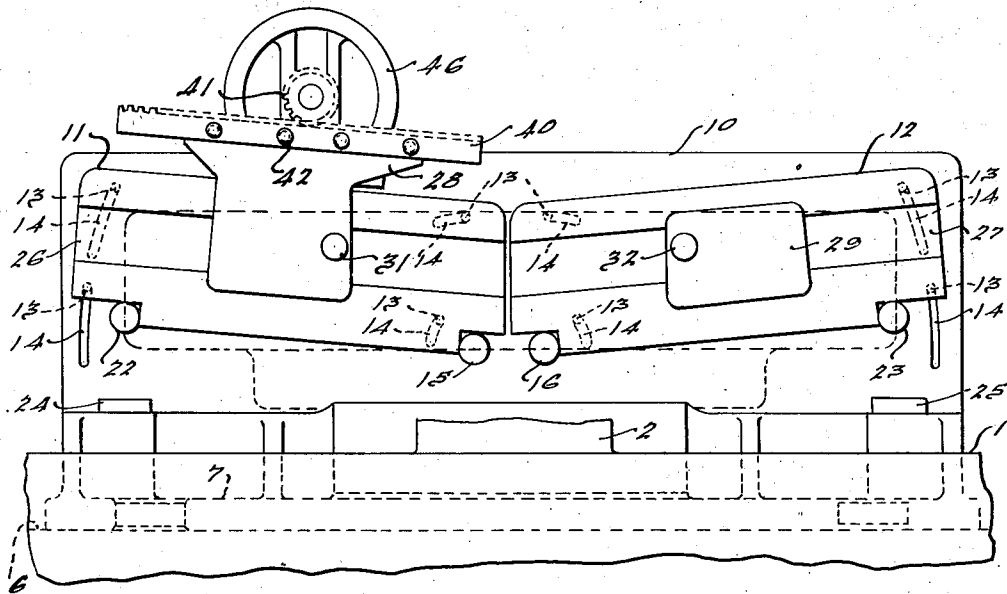


FIG. 4.

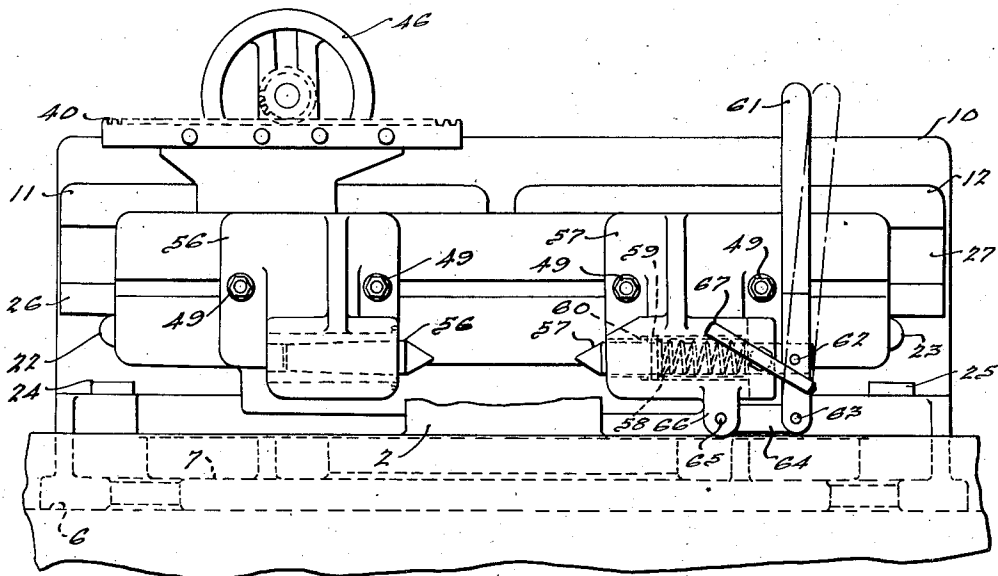


FIG. 5.

INVENTOR.

Calvin E. Hall.

BY

Harness, Dickey & Pierce

ATTORNEYS.

UNITED STATES PATENT OFFICE

2,428,215

MACHINE FOR GRINDING LONG
RADIUS ARCS

Calvin E. Hall, St. Clair Shores, Mich., assignor
to Michigan Tool Company, Detroit, Mich., a
corporation of Michigan

Application October 29, 1945, Serial No. 625,334

3 Claims. (Cl. 51—96)

1

This invention relates to grinding machines and, more particularly, relates to a grinding machine for grinding arcuate surfaces of relatively large radii.

In many instances, it is desirable in the machine tool industry to grind arcuate surfaces having large radii on parts which are not circular, as for example, gear crowning blocks. When such arcuate surfaces have radii beyond the capacity of present grinding machines, the problem of grinding the same is perplexing and difficult. At present, it is customary to locate a series of ordinated points on the piece to be ground and then scribe the desired arc through said points. The arc thus laid out is then ground on a grinding machine after which it is checked by means of gage blocks to determine whether the correct rise has been maintained at each of the ordinated points during the grinding operation. Inasmuch as the accuracy of the work depends entirely upon the ability of the operator, the work can only be satisfactorily completed by an exceptionally skilled operator. The time involved in a grinding operation such as this is considerable and cost is relatively high, particularly where only one or a limited number of parts are to be produced.

I have discovered that by utilizing a simple geometric principle, it is possible to grind a considerable range of arcs of large radii, either convex or concave, with a machine, which may be either a complete grinding unit especially designed for the purpose or a fixture adapted for use with a surface grinder. In either event, extremely accurate work may be accomplished by a relatively unskilled or semiskilled operator.

It is, accordingly, a primary object of this invention to provide a grinding machine for grinding a considerable range of arcuate surfaces of large radii, either convex or concave.

Another object of this invention is to provide a construction for grinding arcuate surfaces of large radii which may be either a complete grinding unit or a fixture adapted for use with a surface grinder.

A further object of this invention is to provide a grinding machine with which such arcuate surfaces may be ground with extreme accuracy by a relatively unskilled or semiskilled operator.

A still further object of this invention is to provide an apparatus for grinding arcs of large radius which requires but little time to set up.

Further objects and advantages of my invention will be apparent from the description which follows when considered in connection with the

2

accompanying drawings in which like numerals indicate like parts wherever shown and wherein:

Figure 1 is a front elevation of a machine embodying the improvements of my invention in which certain of the parts are in phantom or broken away to more clearly show the operation of the machine.

Figure 2 is an elevation of the right side of the machine shown in Figure 1.

Figure 3 is a front elevation of the apparatus with the work holder omitted to more clearly show certain operating parts with the sine bars positioned for grinding a large convex arc.

Figure 4 is a front elevation similar to Figure 3 with the sine bars positioned for grinding a large concave arc.

Figure 5 is a front elevation of a modification of the invention which may be used to grind an arcuate surface having a large radius on teeth of a machine element such as a cutter.

This grinding machine provides a pair of sine bars which may be adjusted to slope in such manner that they form the legs of a widely open V, the vertex of which may point toward or away from the axis of rotation of the wheel on the machine. These sine bars each slidably mount a pivot block, which blocks are interconnected by means of a link for mutual sliding in straight-line paths intersecting at a common point. This sliding movement, effected by means of a reciprocable rack integrally connected to one of such pivot blocks and a rotatable pinion meshing the same, causes the link to shift. A work holder for retaining a workpiece is mounted on this link and shifts with the same, effecting the workpiece to progressively contact the grinding wheel along a path which is an arc of a true circle, either convex or concave, depending upon the attitude of the sine bars.

Referring to the drawings for a more detailed description, a base is provided as is generally indicated at 1. On an upwardly directed post 2, a suitable bearing 3 is mounted in which shaft 4 is journaled to rotatably support a grinding wheel 5. This grinding wheel may be rotated in the usual manner by driving means located interiorly of said base.

The base has a machined surface 6 to which the base plate 7 of a casting, generally indicated at 8, is anchored by bolts 9. Such casting provides an integral, upwardly projecting back plate 10 which is properly supported by ribs. This back plate provides for mounting a pair of sine bars 11 and 12 thereto by means of a plurality of bolts 13 extending through curved, slotted openings

14 to provide for adjusting said sine bars into sloping position radially about pins 15 and 16. Such pins are secured to the sine bars by screws 17 which pass diametrically through said pins to threadably engage said sine bars. These pins are then inserted into the bushings 18 and 19 provided in openings 20 and 21, extending through back plate 10. It is quite obvious, then, that the sine bars may thus be radially moved about such pins.

At the opposite end of these sine bars, pins 22 and 23 are secured thereto in a similar manner. Pins 22 and 23, however, do not pass through back plate 10, but stop short a slight amount from the front face thereof. Immediately below these pins, pads 24 and 25 are located. Said pads each have a ground surface upon which gage blocks may be mounted to contact pins 22 and 23. In this manner, the sine bars may be placed in the desired sloping adjustment after which said bars may be locked thereat by means of the previously described bolts 13.

Such sine bars provide grooves 26 and 27 to receive the dovetails of pivot blocks 28 and 29 for slidable movement therein and are interconnected for mutual movement by plate or link 30. This link is pivotally mounted to said blocks by means of pins 31 and 32, extending through mating openings provided in the pivot blocks and the plate 30, respectively. The openings in the pivot blocks are counterbored to provide a mating surface for the shoulders on the pins such as that indicated at 33 in Figure 2. The openings in the plate are likewise counterbored to receive the bushings 34 and 35 and provide a mating surface such as that indicated at 36, Figure 2, for the shoulders of said bushings. Such bushings receive pins 31 and 32 which are held therein by caps 37 and 38 through which screws 39 pass to threadably engage a tapped opening in the respective pins. Thus, as said blocks slidably move in the grooves provided by the sine bars, a pivotal connection is maintained between each of said blocks and plate 30.

This mutual sliding of the pivot blocks is accomplished by means of a reciprocable rack 40 and a rotatable pinion 41. Such rack is secured to the top of pivot block 28 by a plurality of screws 42. In this position, the rack meshes said pinion which is rotatably supported upon shaft 43. This shaft is journaled for rotation in bearing 44 perpendicular to back plate 10 and, in turn, the bearing is mounted upon an integral support 45 anchored to sine bar 12. This construction permits said bearing to shift as the attitude of the sine bar varies, and, of course, permits the pinion to always positively mesh the rack which likewise shifts with the sine bar due to the slidable connection between pivot block 28 and sine bar 12. It will now be observed that as pinion 41 is rotated by means of the handwheel 46 mounted on the opposite end of shaft 43, the rack will reciprocate, effecting sliding movement of the pivot blocks in the grooves of the sine bars.

Considering now the paths which pins 31 and 32 follow during this sliding movement, it will be observed that such paths lie in straight lines which intersect at a central point. Again, considering the pins as extremities of a chord of a circle whose radius is that of the arc desired on the workpiece 47, it may be further observed that although the circle shifts, as indicated by the attitude of the chord, said circle always passes through this central point, resulting in the desired arc being produced on the workpiece.

To mount workpiece 47 in position so that such arc may be ground thereon, a work holder 48 is secured to plate 30 by means of T-bolts 49 which engage T-slot 50 in said plate. This work holder provides mounting surfaces 51 and 52 disposed at right angles to each other to which the workpiece may be secured by suitable means, and further provides T-slot 53 in one of said surfaces for anchoring such securing means. Thus, after mounting the workpiece to this work holder, handwheel 46 may be rotated and the workpiece fed to the rotating grinding wheel to effect grinding of an arc thereon, the radius of which is that desired.

Up to this point, this invention has been described as a complete grinding machine designed especially for grinding arcuate surfaces having large radii. However, this highly desirable result may also be accomplished by mounting the machine as a fixture on the table of a surface grinder. In this event, casting 8, carrying the various elements, may be secured to such table and the desired arcuate surface generated as described in the foregoing.

Should it be desired to manufacture a relatively large number of pieces with arcuate surfaces, all of which have the same large radius, it is often expedient to grind an arc of similar radius, but opposite profile, on the teeth of a cutter which may then be used for milling the desired arc on the pieces. With the modified form of my invention illustrated in Figure 5, an arcuate surface having a large radius may be ground on the teeth of a cutter. In this machine, a pair of brackets 54 and 55 are mounted to plate 30 by means of T-bolts 49. It is obvious that such brackets are adjustably mounted by means of the T-bolts in order to accommodate cutters of various lengths. These brackets provide centers 56 and 57 between which a cutter may be rotatably supported.

In order to facilitate loading and unloading of the cutters, center 57 is slidably maintained in position by annular compression spring 58, which is disposed between shoulder 59 on said center and one end wall of the bracket. In this manner, such center is held with shoulder 59 abutting shoulder 60 provided by bracket 57. When it is desired to withdraw this center, lever 61, which is pinned at 62 to such center, may be moved outwardly as indicated by the dash lines. To effect such withdrawing of the center, lever 61 is pinned at 63 to a link 64 which, in turn, is pinned at 65 to an outwardly directed projection 66 of bracket 57. After loading the cutter between the centers, the slidable center may be securely and positively locked in position by means of hand screw 67 which prevents further sliding of the center until it is again unlocked.

When the cutter is positioned between the centers as described, it may be rotated manually or by any suitable means as it is fed to the rotating grinding wheel by means of handwheel 46 and the desired arc ground on the teeth thereof as described in the foregoing.

It will be clear from the foregoing description that the grinding machine shown in the drawings and described above has been illustrated and described in rather specific detail. Obviously, many modifications, changes, and departures from the above described construction may be made without departing from the generic spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A grinding machine for grinding arcuate surfaces of large radii, said machine having a base, a rotatable grinding wheel thereon, means to rotate said wheel, a supporting element anchored to the base, a pair of sine bars grooved throughout the length thereof and each pivotally mounted on said supporting element, said sine bars each being arcuately movable about its respective pivot to bring the sine bars into predetermined opposite sloping angular adjustment, a pivot block slidably mounted in the groove in each sine bar, said blocks each being slidably shiftable and positively guided, a plate pivotally connecting the pivot blocks, a work holder mounted on said plate and adapted to retain a workpiece for movement in the plane of rotation of the grinding wheel, a reciprocable rack mounted on one of said pivot blocks, a pinion rotatably mounted on the supporting element and adapted to engage the rack for effecting reciprocation thereof when said pinion is rotated whereby to shift said blocks and bring the workpiece into contact with the grinding wheel along a path which is an arc of a circle.

2. A grinding machine for grinding arcuate surfaces of large radii, said machine having a base, a rotatable grinding wheel thereon, means to rotate said wheel, a supporting element anchored to the base, a pair of sine bars grooved throughout the length thereof and each pivotally mounted on said supporting element, said sine bars each being arcuately movable about its respective pivot to bring the sine bars into predetermined opposite sloping angular adjustment, a pivot block slidably mounted in the groove in each sine bar, said blocks each being slidably shiftable therein and positively guided, a plate pivotally connecting the blocks, a workholder slidably mounted on said plate for movement into predetermined adjusted position relative to the axis of rotation of the grinding wheel and adapted to retain a workpiece for movement in the plane of rotation of said wheel, a reciprocable rack mounted on one of said pivot blocks, a pinion rotatably mounted on the supporting element and adapted to engage the rack for effecting reciprocation thereof when said pinion is rotated whereby to shift said blocks and bring the workpiece

into contact with the grinding wheel along a path which is an arc of a circle.

3. A grinding machine for grinding surfaces of large radii, said machine having a base, a rotatable grinding wheel thereon, means to rotate said wheel, a supporting element anchored to the base, a pair of sine bars grooved throughout the length thereof and each pivotally mounted on said supporting element, said sine bars each being arcuately movable about its respective pivot to bring the sine bars into predetermined opposite sloping angular adjustment, a pivot block slidably mounted in the groove in each sine bar, said blocks each being slidably shiftable therein and positively guided, a plate pivotally connecting the pivot blocks, a pair of opposed brackets slidably mounted on said plate for movement into predetermined adjusted position relative to the axis of rotation of the grinding wheel, a fixed center in one bracket and a slidable center in the other bracket adapted to rotatably support a workpiece therebetween, means on the last named bracket to shift the slidable center therein for removing a workpiece without disturbing the adjustment of the brackets, means on said last named bracket to lock said slidable center therein during a grinding operation, a reciprocable rack mounted on one of said pivot blocks, a pinion rotatably mounted in the supporting element and adapted to engage said rack for effecting reciprocation thereof when said pinion is rotated whereby to shift said blocks and bring the workpiece into contact with the grinding wheel along a path which is an arc of a circle.

CALVIN E. HALL.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,320,672	Stein	June 1, 1943
1,682,412	Palmer	Aug. 28, 1928
164,897	Wood	June 22, 1875
2,072,951	Johnson et al.	Mar. 9, 1937
1,472,827	Erdman	Nov. 6, 1923
2,385,330	Candee et al.	Sept. 25, 1945