B. M. W. HANSON & C. L. GROHMANN.

GRINDING MACHINE.

APPLICATION FILED NOV. 11, 1909.

1,000,516. Patented Aug. 15, 1911.

3 SHEETS—SHEET 1.

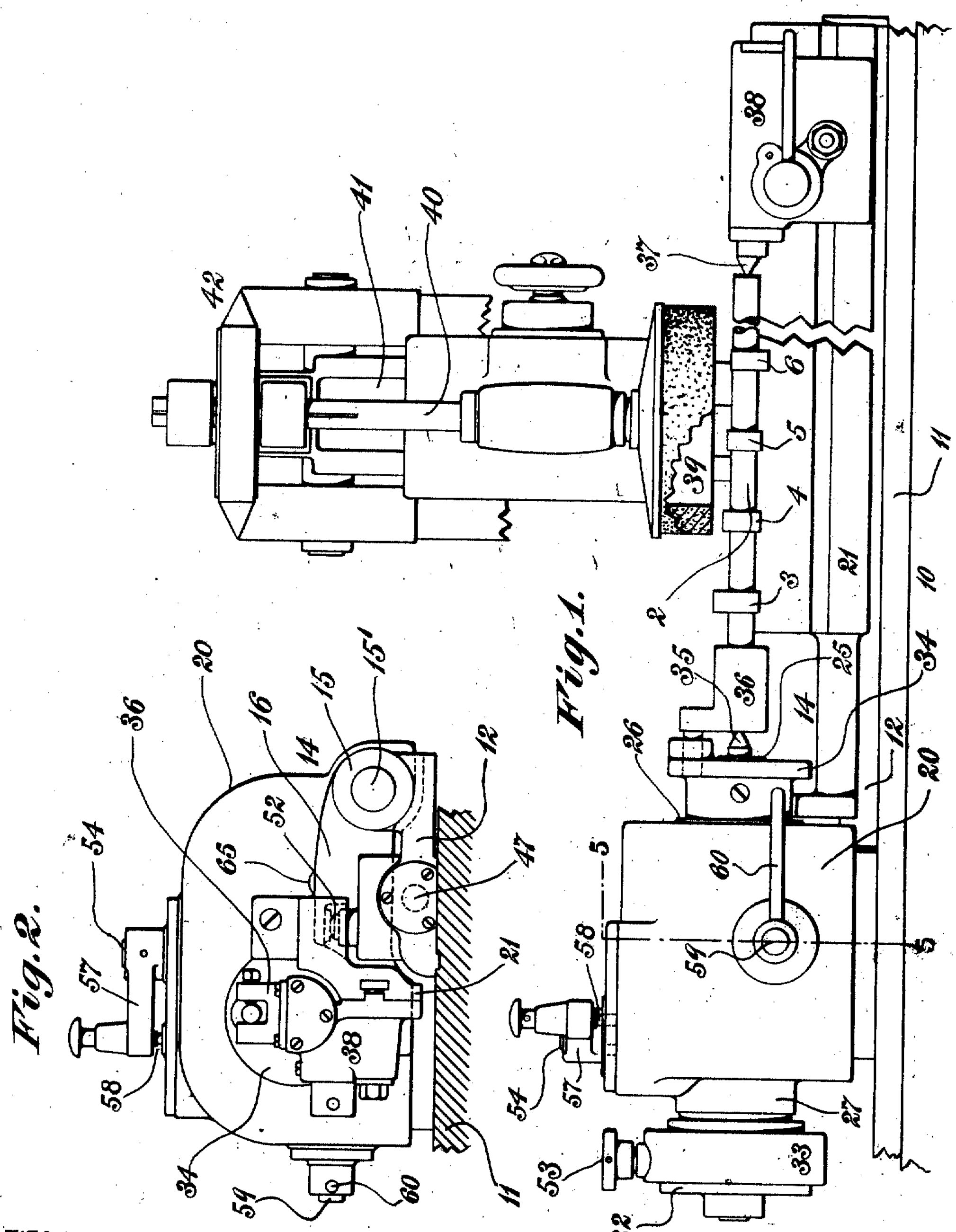

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Fig. 3.

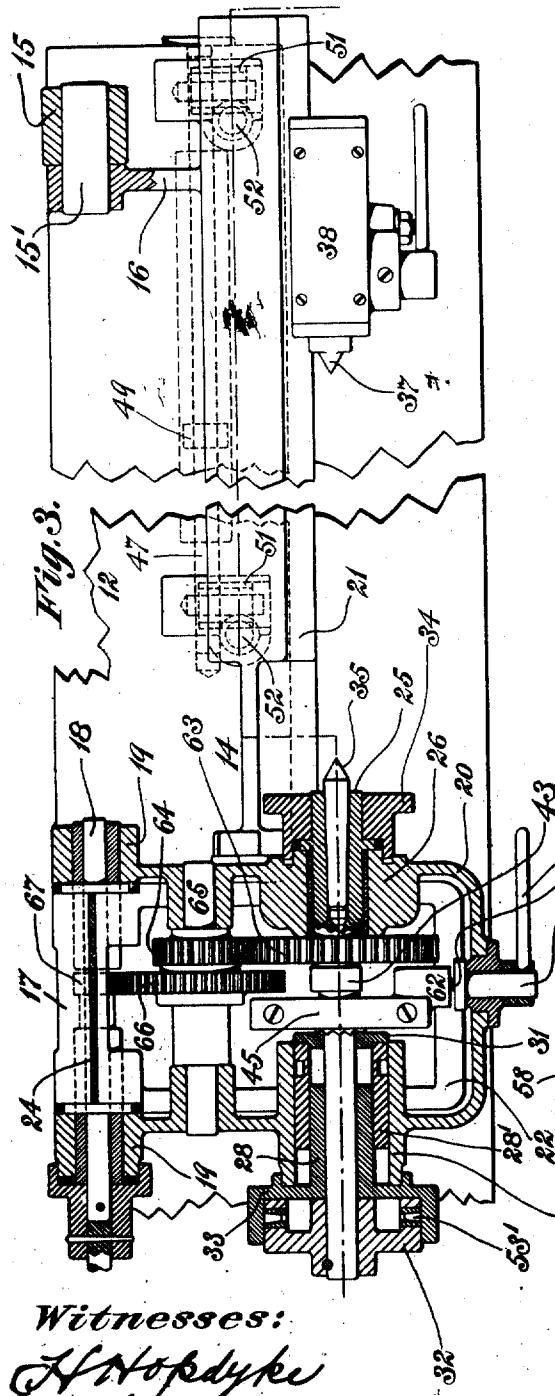
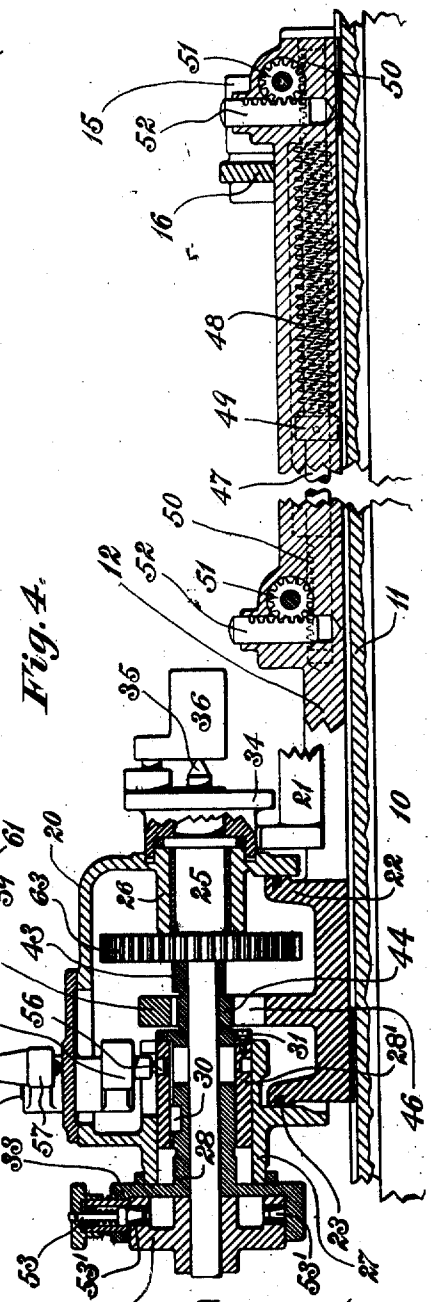


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 5.

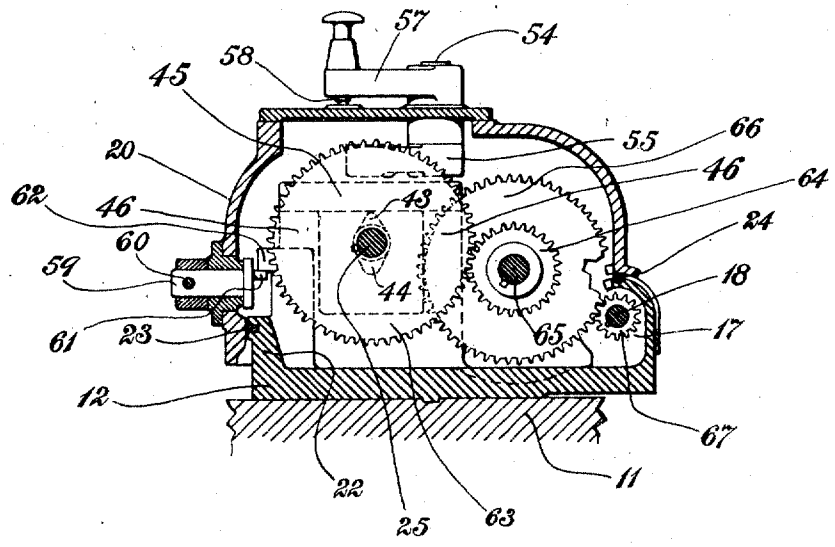
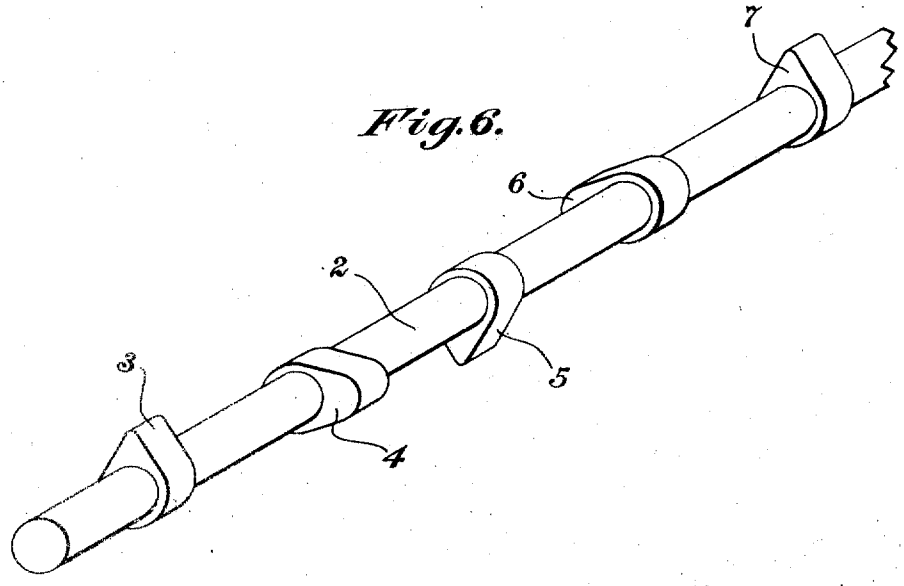


Fig. 6.



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UNITED STATES PATENT OFFICE.

BENGT M. W. HANSON AND CARL L. GROHMANN, OF HARTFORD, CONNECTICUT, ASSIGNORS TO PRATT & WHITNEY COMPANY, OF HARTFORD, CONNECTICUT, A CORPORATION OF NEW JERSEY.

GRINDING-MACHINE.

1,000,516. Specification of Letters Patent. Patented Aug. 15, 1911.

Application filed November 11, 1909. Serial No. 527,392.

To all whom it may concern:

Be it known that we, BENGT M. W. HANSON and CARL L. GROHMANN, citizens of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Grinding-Machines, of which the following is a specification.

This invention relates to what we shall for convenience term, a "grinding machine," the object of the invention being to provide a machine of this character wherein accurate and precisionized results can be secured irrespective of wear of the active face of the reducing member, which is preferably, though not necessarily, a grinding wheel. In the present instance said machine includes means for moving the work through a predetermined path and a work-reducing member the form of the cutting, grinding or acting face of which latter remains unaltered by virtue of which we can secure the precise and exact results to which allusion has been made. The shape of this grinding member may vary greatly although the operating face of that hereinafter described, is flat; this, however, is not a matter of importance. We prefer to move the work through an irregular path which will depend upon the contour or outline of the work or article to be ground.

The machine is capable of general use although it is of especial utility, as will hereinafter appear, for grinding cams, being so organized that cams of different form can be ground with equal accuracy. In a machine with which we are familiar, for grinding cams the work is moved through an irregular path and a grinding wheel is employed for reducing the peripheral portion of the cam-blank or work, said grinding wheel being made in the form of a rotary disk and the peripheral portion of which is the active part thereof. At the outset such a type of wheel can be employed for securing more or less accurate work but as the wheel peripherally wears away, its diameter and radius are reduced and such reduction naturally affects the form of the work being ground especially where such work is irregular in outline as in the case of a cam. In the old machine the work moved through a definite path, being regulated preferably by pattern mechanism, and the instant that there is any appreciable variation in form of the old grinding wheel, as by reduction in radius thereof, the form of the work is at once affected. In our case the form of the reducing member, of whatever nature it may be, remains unaltered irrespective of wear so that the form of the work never varies.

The machine may be employed for various purposes although it is of especial utility for grinding the valve-operating cams found on the shafts of hydrocarbon motors.

In the drawings accompanying and forming part of the present specification we illustrate in detail one convenient form of embodiment of the invention which to enable those skilled in the art to practice said invention will be fully set forth in the following description while the novelty of the invention will be included in the claims succeeding said description. We do not restrict ourselves to the disclosure thus made as many variations may be adopted within the scope of our invention as expressed in our said claims.

Referring to said drawings, Figure 1 is a front elevation of a grinding machine including our invention. Fig. 2 is an end elevation of said machine as seen from the right in Fig. 1, the grinding wheel and its adjuncts being omitted. Fig. 3 is a top plan view. Fig. 4 is a longitudinal section of the machine and in which as in the two preceding views said grinding wheel and cooperating parts are now represented. Fig. 5 is a cross section on the line 5—5 of Fig. 1. Fig. 6 is a detail view in perspective of a class of work upon which the machine can operate.

Like characters refer to like parts throughout the several figures.

While the present invention has been styled a grinding machine it is more in the nature of an attachment for such a machine in that it can be mounted upon grinding machines as they are now made without material, and in some cases any, changes therein.

The style of work may vary considerably although the machine is of such a character that it can advantageously operate upon that to which specific allusion has already been made and a specimen of which is shown in Fig. 6.

The work will be denoted by 2 and it con-

sists of a shaft provided with rigid cams, usually made integral therewith, and designated, respectively, by 3, 4, 5, 6 and 7. So far as the cams 3, 5 and 7 are concerned their contour is the same and this statement applies to the cams 4 and 6. But the number and style of the cams may be very different from those illustrated and the work, as will be gathered from what has already been stated, may be of a radically different nature from that shown.

The different parts of the machine may be mounted upon a bed as 10 and in the present case one element thereof is a platen as 11 which has a longitudinal, sliding movement on said bed. A platen is a common device in grinding machines so that it is not necessary to go into detail with respect to the construction and mode of operation thereof it being usual to operate the platen, which carries the work, back and forth during the grinding operation so that the grinding wheel can operate laterally upon the work the tool being bodily immovable horizontally although rotative and capable of being vertically adjusted. Preferably associated with said platen 11 so as to partake of the longitudinal movements thereof is the attachment or fixture in which the invention is incorporated and this attachment or fixture involves in its make-up a suitable base-member as the plate 12 which may be and as shown is bolted to the platen. There may of course be cases where it would not be necessary to provide the platen or any equivalent reciprocative part.

The base member or plate 12 constitutes a convenient support for a swinging member which directly carries the work and which during grinding is automatically vibrated preferably by cam and spring mechanisms so as to bring accurately successive portions of a cam which is being ground under the action of the grinding-wheel hereinafter described, or its equivalent.

The cam mechanism to which reference has been made comprises one or more cams and each cam, where more than one is present, is an exact counterpart of the cam being ground by reason of which precision in results are assured. There are two shapes of cams on the shaft 2 and it therefore follows that the cams which are utilized for effecting the action of the vibratory member are two in number and they and their action will be hereinafter more fully described. A swinging or vibratory member such as satisfactorily answers the requirements is that denoted in a general way by 14. Therefore a movably mounted work support or carrier is provided which though preferably mounted for swinging or pivotal motion need not necessarily be so mounted.

Upon the rear side of the plate 12 there is shown as rising near one end thereof, the bearing 15 which supports the stud shaft 15′ extending through a rearwardly-extending arm 16 of the swinging member or work-carrier 14 while from the opposite end portion of said plate 12 there rises a bearing member 17 in line with the bearing 15. Said bearing member 17 presents a convenient support for the rotary shaft 18 which extends freely through hubs 19 of the casing 20 constituting a rigid part of the rocking or swinging member 14 and said casing incloses certain gearing and other devices hereinafter described. The driving-shaft 18 and the stud shaft 15′ the axes of which are co-incident, present suitable pivotal supporting means for the swinging or rocking member 14. The arm 16 and the casing 20 are connected by an elongated bar 21 and this bar serves conveniently as a support for a tail center block as will hereinafter more particularly appear. The shaft 18 may be rotated in any desirable manner and as will be obvious it serves a dual function.

From the base member or plate 12 there is shown as rising a substantially U-shaped flange 22 and the pendent portion of the casing 20 (open in the bottom as shown) traverses the exterior of this flange a packing as 23 being interposed between said pendent portion and the flange so that a means is provided for effectually excluding flying particles from the front and sides, from entering said casing. This packing is shown as fitted in a groove in the outer surface of said flange 22. The back of said casing oscillates upon the bearing member 17 and between said back and bearing member a packing 24 may be placed said bearing member in the present case carrying said packing so that by this construction it is not possible for foreign substances to enter said casing by way of its open bottom.

A work-spindle is shown at 25 and as will hereinafter appear this spindle is geared to the shaft 18. The said spindle is shown supported near its head end by a hub 26 on the inner side of the casing 20. The other side of said casing has a hub 27 complemental to the hub 26 and within said hub 27 is shown a sleeve 28 which surrounds and turns on said spindle 25 but which is not directly supported by the hub 27. In telescoped connection with said sleeve 28 is a second sleeve 28′ which is directly supported by and within said hub 27. The sleeve 28′ has an endwise movement with respect to the shaft or spindle 25 and the companion sleeve 28 the two being connected together by a key as 30. From this it will be evident that the two sleeves can turn as one and that while the sleeve 28′ can slide back and forth the sleeve 28 has no such movement and the means whereby this is possible will be hereinafter stated. A disk as 31 is shown as closing the inner open end of the slidable

sleeve 28′ and the two parts are rigidly connected together in some suitable manner as by screws. These two sleeves it might be stated at this point constitute parts of indexing and shifting means for pattern cams such as will hereinafter be described although it should also be stated that very different means might be employed to obtain the desired functions and it is conceivable that there might be cases where no such mechanisms need be employed. There is shown as pinned to the outer end of the spindle 25 a disk 32 the hub of which bears against the sleeve 28 while a disk as 33 on the outer end of said sleeve 28 has a bearing against the hub 27 and the two described devices prevent as will be apparent, sliding movement of the sleeve 28 on the spindle or shaft 25. The indexing and cam mechanism has been only briefly described; it will be described more in detail hereinafter. The spindle 25 is equipped with a face-plate 34, center 35 and driver dog 36 by which the work can be supported and driven in connection with a second center as 37, the shaft 2 to which reference has been made being mounted between and centered by said centers 35 and 37. The center 37 is illustrated as supported by a block 38 which has a sliding movement on the bar 21 the usual or some suitable means being provided to effect the movement back and forth of said block on said bar and the independent adjustment of said center 37. The work is therefore rotated after the method in general use in lathes of various types.

The wheel 39 may be provided for grinding the cams 3 to 7 inclusive and said wheel is fixed to a vertically-disposed shaft 40 which is supported by a standard 41 on the bed 10 of the machine the shaft as usual in grinding machines being longitudinally adjustable. It may be driven by belting as that denoted in a general way by 42. The faces of the cams to be ground are operated upon while the platen is being automatically reciprocated although it might be operated by hand.

There are as will be clear from what has been stated two pattern cams or templets and they are denoted respectively by 43 and 44 the pattern cam or templet 43 corresponding for example in shape with the cams 3, 5 and 7 while the pattern cam or former 44 corresponds in shape with the cams 4 and 6. The pattern cams as will be evident are coaxial with the spindle 25 and they also turn with said spindle. They are preferably integral with each other and with the plate or disk 31 which constitutes in effect a part of the sleeve being rigid therewith as previously described. Said pattern cams or formers 43 and 44 are alternately coöperative with a shoe as 45 which in the present case is in the nature of a bridge connecting two posts or uprights as 46 rising from the base plate 12 and between which the spindle 25 has its combined vibratory and rotative motions. The shoe 45 is therefore stationary with respect to the swinging member 14. The cam 44 is in contact with the shoe or bridge piece 45 and it will be so placed (by the indexing mechanism hereinafter described) as to be in alinement with the cams 4 or 6 said indexing mechanism providing for the angular adjustment of the two pattern cams. For instance the cams 4 and 6 extend exactly oppositely from the shaft 2 and it will be evident that the pattern cam 44 must be adjusted by the index mechanism to agree with such two dispositions. It will be assumed that the pattern cam 44 has been so placed as to agree exactly with the disposition of the cam 4. Therefore the pattern cam is initially placed against the relatively fixed shoe 45 after which the grinding wheel 39 is brought into contact with the periphery of the cam on the work which is in alinement with the pattern cam. It will be assumed that the pattern cam 44 has been adjusted to effect the grinding of the cam 4. Said pattern cam 44 and spring mechanism hereinafter described or analogous means, will so conjointly vibrate the swinging member 14 that the grinding wheel is caused to accurately grind the cam 4. It will be assumed that it is desired to grind the cam 6. To do this the pattern cam 44 must be placed in a position exactly opposite to that already referred to. To grind the cams 3, 5 and 7, the pattern cam 43 must be utilized and said pattern cam 43 will be so adjusted that it will be in precise alinement longitudinally of the machine with the particular cam to be ground whether it be that numbered 3, 5 or 7. It will be apparent that as a cam is being ground the spindle 25 is being turned, and that as the grinding progresses the tool shaft or spindle 40 can be advanced step by step automatically or by hand.

The pattern means operates the swinging member in one direction while spring means one advantageous form of which will now be set forth operates said swinging member 14 in the opposite direction to the pattern cam means.

There is shown as situated under the base plate 12, a rod 47 the said plate having on its underside suitable bearings to receive said rod for sliding movement and encircling said rod is a push spring 48 bearing at one end against the plate 12 and at the other against a collar 49 on said rod the tendency of the spring being constantly to force said rod to the left in Fig. 4. Said rod is shown as having near its opposite extremities and on the upper side thereof rack teeth 50 which mesh respectively with pinions 51 rotative in bores or chambers in the plate 12.

The teeth of the pinions mesh with teeth on the vertically-movable plungers 52 slidable in vertical openings in said plate 12. By reason of the described construction the two plungers are forced upward at all times and in absolute unison. Said plungers in the present case bear at their upper ends against the underside of the swinging member 14 and therefore exert a constant tendency to swing said member 14 upward which is resisted by the cams 43 and 44 in alternation, when the spindle or shaft 25 is in motion.

The disk 33 hereinbefore described is shown as being of cup shape and on the rim or flange portion thereof is shown a spring-plunger 53. It will be obvious that by turning the disk 33 the angular positions of the cams 43 and 44 may be adjusted to put one of them into exact alinement longitudinally of the machine of a cam of the shaft 2, which is to be ground. The tip or inner end of this plunger 52 is adapted to successively enter seats or perforations 53′ in the rim or flange portion of the cup-like disk 32 which it will be observed fits within the companion disk so that when said plunger is seated the two disks are rigidly and substantially coupled together. There are usually four holes 53′ although their number may vary.

Extending vertically of the casing and supported rotatively by the top thereof, is a short shaft 54 to the lower end of which is fastened an arm 55 provided with a pendent stud or pin 56 to enter an opening or seat in the slidable sleeve 28′ and it therefore follows that by swinging the arm 55 the cams 43 and 44 can be brought alternately under the bridge or shoe 45 to put said cams alternately into action. Said shaft 54 is shown provided at its upper end with a manually-operable arm 57 by which the lower arm 55 can be swung to secure the alternate cooperation of said cams 43 and 44 with the bridge or shoe 45, said arm 57 being provided with a latch 58 to alternately engage properly positioned openings in the top of the casing 20 to thereby rigidly maintain the sleeve 28′ in its two shifted positions.

The forward wall of the casing supports for rocking movement a short shaft 59 provided at its outer end with a handle or crank-arm 60 by which said shaft can be easily turned. The said shaft is provided at its inner end with an eccentric stud or pin 61 which bears against a shoulder 62 on the base-plate 12 and which may be formed on the forward upright 46. By turning said shaft 59 the rocking frame 14 can be swung down to permit that cam (43 or 44) which is not in action, to clear the bridge or shoe 45 on the movement longitudinally of the sleeve 28′.

To the shaft or spindle 25 there is shown fastened a spur-gear 63 in mesh with a pinion 64 the shaft 65 of which is rotatively supported by the opposite side walls of the casing 20. The pinion 64 is fastened to said shaft 65 and to the latter is fastened a spur-gear 66 in mesh with the pinion 67 on the main or driving shaft 18 by reason of which when the shaft 18 is in motion the work-spindle or shaft 25 can be also driven and will be kept in motion irrespective of the different angular positions of the swinging member or work-carrier 14.

We have described rather in detail one form of embodiment of the invention so that as hereinbefore intimated, those skilled in the art can properly practice the invention. The machine may be radically changed as our invention does not reside in any particular means or mechanism but rather in certain broad relations as will appear in our claims. We have initially made a brief reference to the more prominent features of the invention and hereinafter will refer to these more in detail.

From the statements already made it will be apparent that we provide means for moving the work through a definite or predetermined path and that we reduce the periphery (which in the present case is irregular) of the work by a device the form of the active or cutting face of which remains unaltered or unchanged by wear. We have found that we can with advantage employ a grinding-wheel such as 39 the active face of which is flat and which is also preferably approximately at right-angles to the axis of motion of the wheel. We have provided a movable carrier for the work equipped with means for rotatively supporting the work. This carrier may as described be given an oscillatory movement by means including a pattern cam owing to which every part of the irregular surface to be ground is brought into a definite grinding path which in the present case is straight or a plane. The master cam need not of course conform to the shape of the cam or work to be ground nor need the two parts be equal in size. By the construction described as the carrier 14 is oscillated during which motion the pattern cam is turning against the flat guide face of a controlling member as the bridge 45, every part of the work is brought into this grinding plane, and the effect is as though the irregular surface to be ground of the work was rolled along a flat surface and owing to the fact that the active face of the reducing member is parallel with this plane or assumed surface it follows that the form of the cam to be ground will never vary so long as the movement of the work to be ground remains constant or definite.

It will be assumed that the work is being moved through the desired path by the mechanism described and that the peripheral portion of the disk operates upon the irregular surface to be ground. At the out-

set the form of the work would be as desired but when the said wheel is adjusted to take up wear the periphery of the adjusted wheel will bear a different relation to the periphery of the work so that the form of the latttr will be changed, owing to the fact that the form of the wheel has changed. That is to say the reduction in size of the wheel causes a difference in radius thereof; the convexity of the peripherally-worn wheel will not be the same as it was originally. In the case of a wheel such as we employ the shape of the active or cutting portion thereof never varies notwithstanding the fact that said active face may be worn away by use.

It will be evident from the observations already made that we provide means for holding irregular work and a reducing device for the irregular surface of the work, and that we associate therewith means for causing a relative motion of the work and reducing device and for also causing said reducing device to operate upon all parts of said surface and at the same time maintain a fixed or definite relation between said surface parts and the active face of the reducing member irrespective of wear of said face.

What we claim is:

1. A grinding machine comprising a vibratory member provided with a rotary work-supporting spindle, a pattern device carried by and rotative with said spindle, a relatively fixed part against which said pattern device turns, and a flat-faced grinding wheel to act upon the peripheral portion of the work.

2. A grinding machine comprising a vibratory member provided with means for rotatively supporting the work, a pair of pattern devices coaxial with the work, means for putting said pattern devices alternately into action, and a grinding wheel to operate upon the work.

3. A grinding machine comprising a vibratory member provided with means for rotatively supporting the work, a pattern cam operative against said carrier, and a pair of simultaneously-operative, spring-actuated devices for acting against the said vibratory member in opposition to said pattern device.

4. A grinding machine comprising a vibratory member provided with means for rotatively supporting the work, a grinding wheel to act against the work, a pair of plungers acting against said vibratory member, a spring-operated rod, and means for transferring the effect of said rod to both said plungers.

5. A grinding machine comprising a vibratory member provided with means for rotatively supporting the work, a pair of pattern devices rigid with each other and rotative about the same axis as the work, and a relatively fixed part against which the pattern devices are adapted to operate said pattern devices being shiftable to put the same alternately into engagement with said relatively fixed part.

6. A grinding machine comprising a work carrying member provided with a rotary work supporting spindle, and a grinding tool, one of said parts being mounted for movement in the direction of the axis of motion of the work to laterally reduce the latter, and mechanism including a pattern, for imparting movement to said work carrying member to bring different circumferential portions of the work thereof under the action of said grinding tool.

In testimony whereof we affix our signatures in presence of two witnesses.

BENGT M. W. HANSON.
CARL L. GROHMANN.

Witnesses:
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HEATH SUTHERLAND.