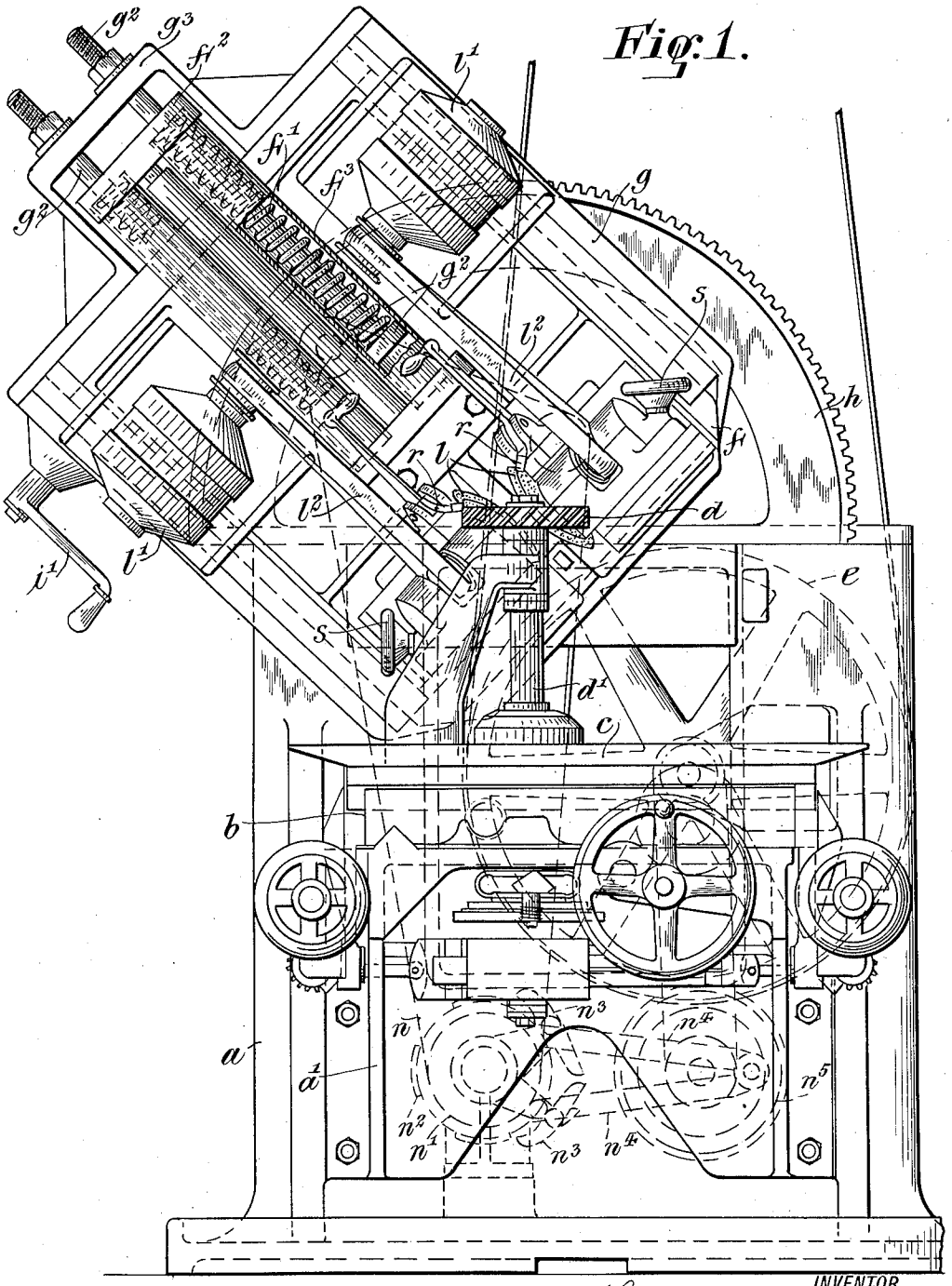
June 15, 1926. 1,588,928

G. WIRRER

GEAR GRINDING MACHINE

Filed May 26, 1924 6 Sheets-Sheet 1

Fig. 1.



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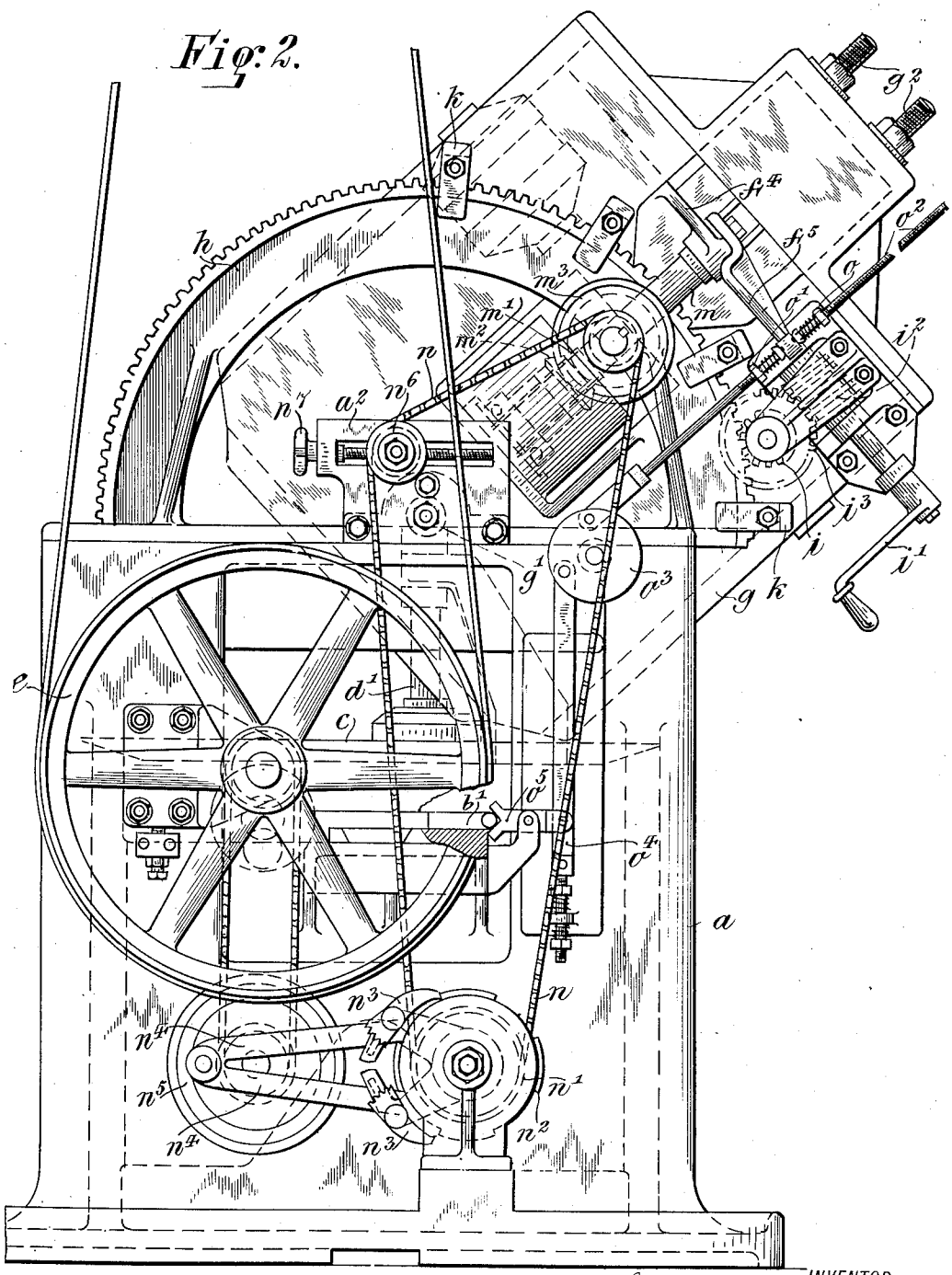
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Fig. 2.



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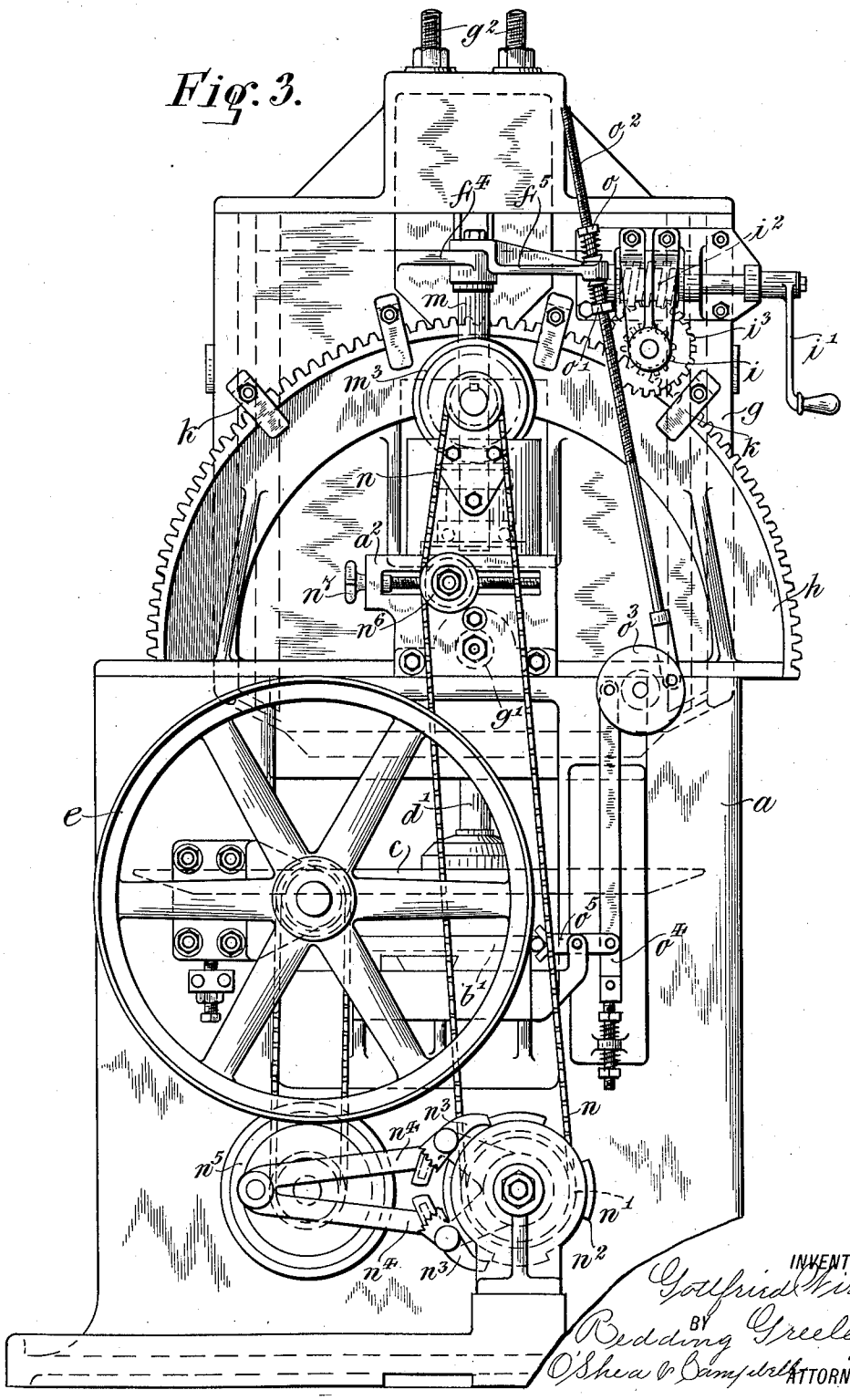
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Fig. 3.



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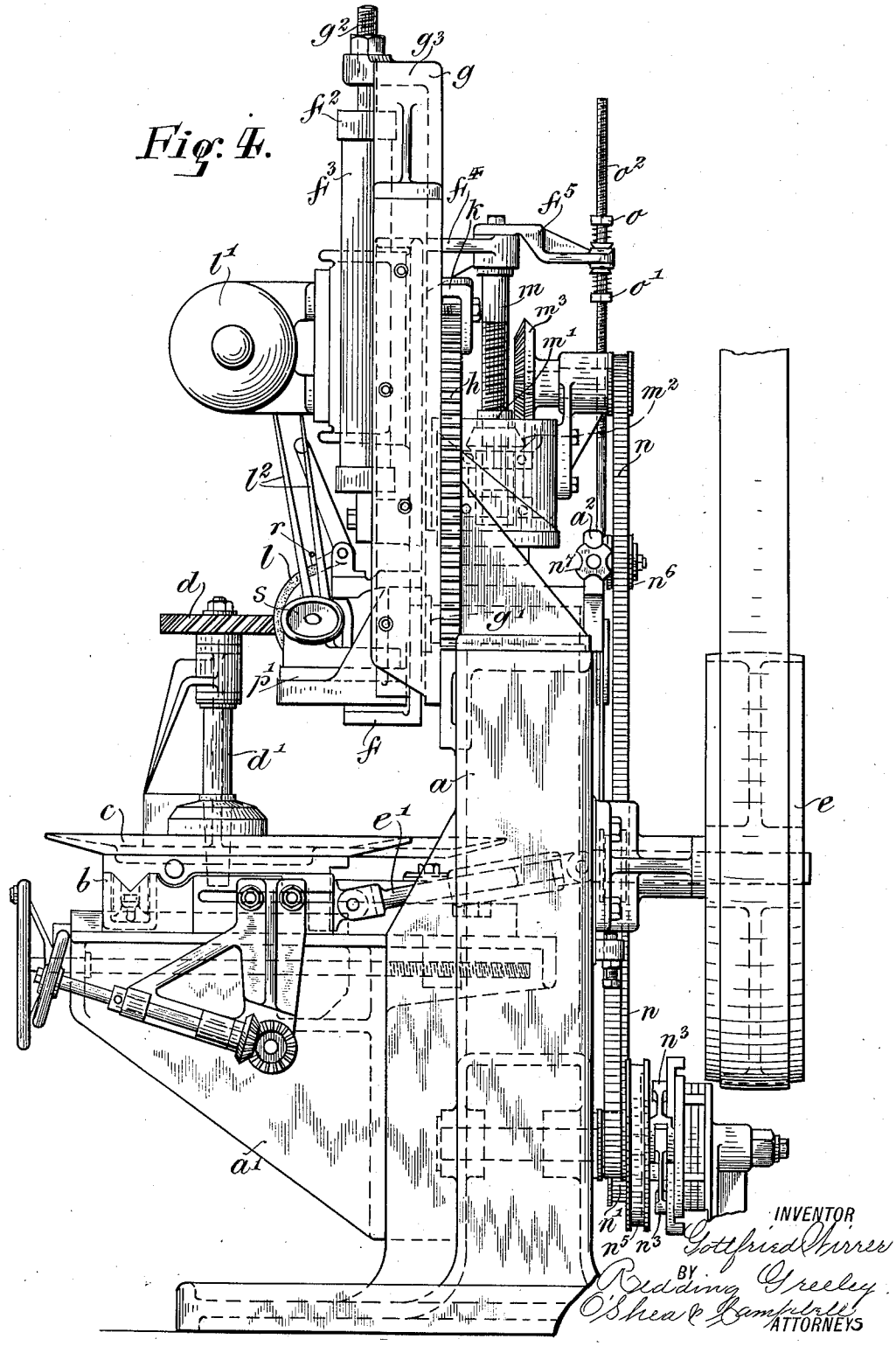
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Fig. 4.



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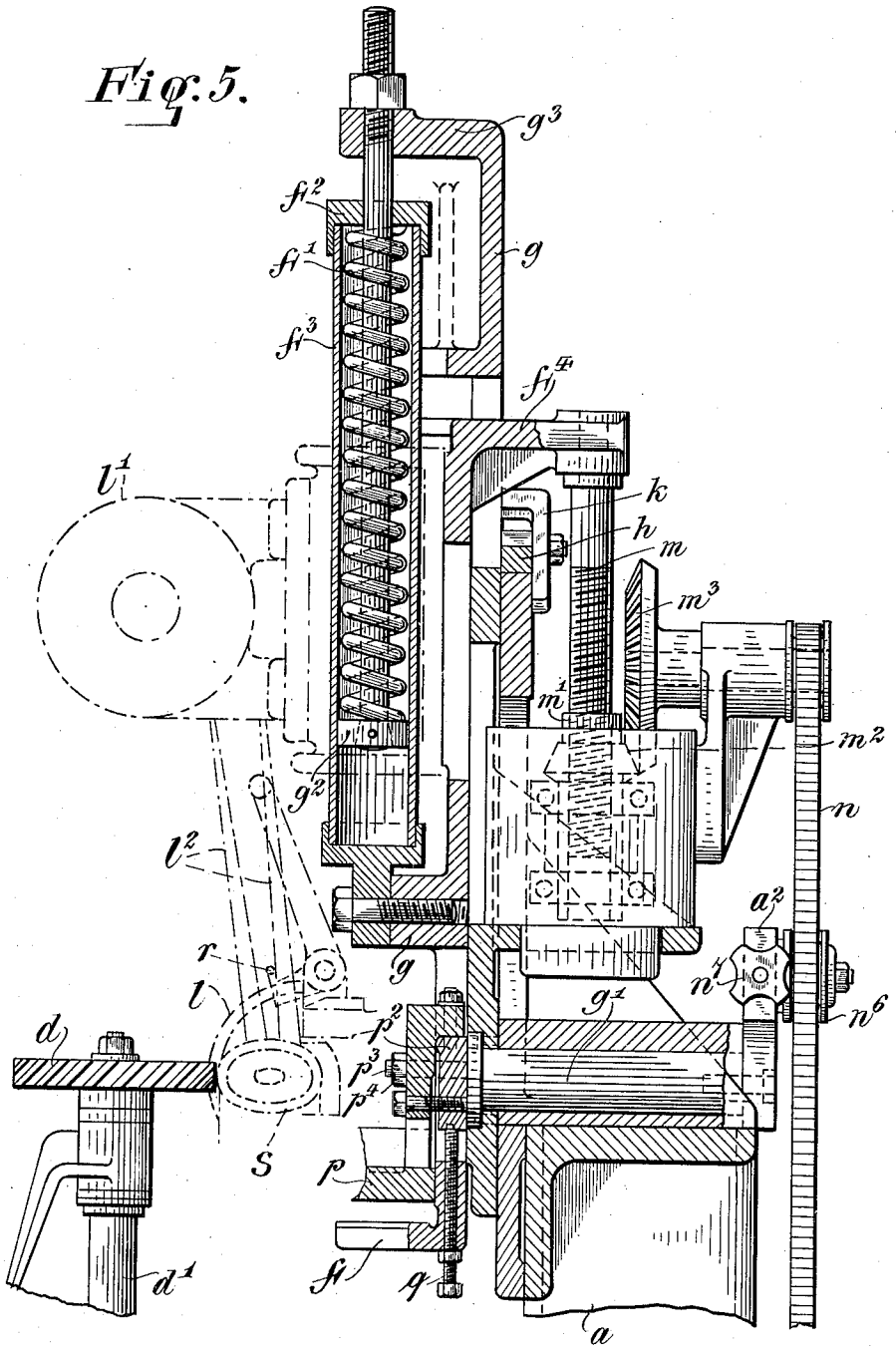
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Fig. 5.



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Fig. 6.

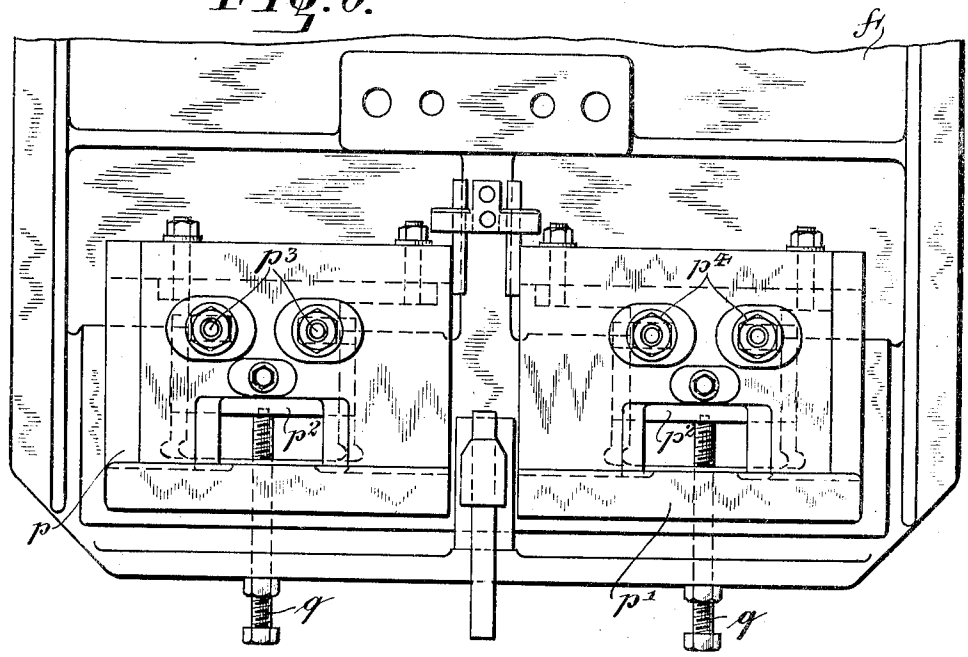
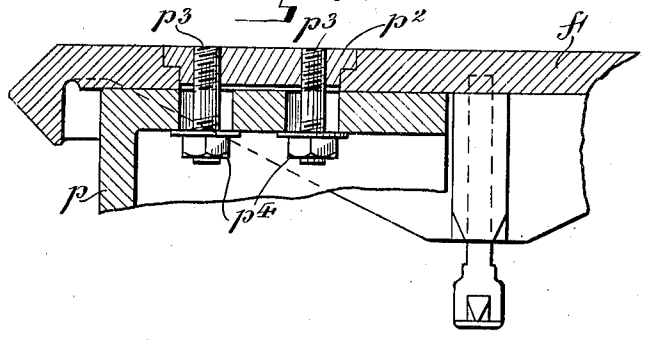


Fig. 7.



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UNITED STATES PATENT OFFICE.

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GEAR-GRINDING MACHINE.

Application filed May 26, 1924. Serial No. 715,806.

This invention relates to machines for grinding gears and is particularly concerned with a machine for grinding helical gears so that they will run true and roll perfectly when in mesh. In a co-pending application filed by the present applicant on June 21, 1923, Serial No. 646,737, there is described and claimed broadly many of the features of construction which are embodied in the present machine and as to those features reference is to be had to said co-pending case in so far as necessary for a more complete understanding of minor details, emphasis being placed in the following description particularly on such characteristics as are peculiar either in principle or form to the present machine.

While it will appear to one skilled in the art that the movements employed for the carrying on automatically of the sequential steps of grinding in the present machine may be adopted for use in grinding gears of any form, since some problems peculiar to the grinding of helical gears present themselves and since this machine will probably find its greatest usefulness in such work the drawings and description are addressed particularly to such a field.

The teeth of helical gears are formed on an arc transversely of the face and satisfactory means have not been devised for enabling a grinder to be moved automatically into and out of proper relation to the surface of the tooth to be ground with such nicety as to insure the greatest degree of accuracy. Further, no means have been devised heretofore for carrying on the grinding simultaneously of two teeth of a helical gear by separate grinding elements which are mounted in spaced relation and which may be brought simultaneously into and out of engagement with the teeth being ground.

The principal object of the present invention is to incorporate in a machine having all of the advantages present in the machine shown in said co-pending application, Serial No. 646,737, a reciprocating head carrying the grinding elements which is adjustable angularly to move along the helix angle of the teeth. A further object is to support on such a head a pair of grinding elements which are independently adjustable thereon so that one may be displaced with respect to the other to an extent sufficient to insure their simultaneous engagement with the respective teeth to be ground and the completion of the grinding with respect to such teeth at the same time. Still another object of the invention is to mount the head for angular adjustment about an axis which passes through the point at which the grinding takes place so that angular movement of the head with its grinding elements brings about minimum bodily movement of the grinding elements with respect to the work.

These and other objects of the invention will appear at greater length hereinafter in connection with the detailed description of the embodiment shown in the accompanying drawings, in which:—

Figure 1 is a view in front elevation of the improved machine.

Figure 2 is a view in rear elevation thereof with the reciprocating head set at an angle for grinding helical gears.

Figure 3 is a view similar to Figure 2 but showing the reciprocating head disposed in a vertical plane in which position the grinding elements may be used for grinding other gears than helical gears.

Figure 4 is a view in side elevation of the improved machine.

Figure 5 is a fragmentary view in section and on a somewhat larger scale showing the spring counterbalance for the head and the relation between the main frame, the head, the work and one of the grinding elements.

Figure 6 is a detailed view showing the independent adjustable slides on which the respective grinding elements are supported.

Figure 7 is a detailed view in horizontal section through a part of the main slide and one of the supporting brackets for a grinding element, as illustrated in Figure 6.

Support for the work and devices for imparting desired movements thereto.

In the present construction provision is made for rolling the gear during grinding and for withdrawing it laterally away from the grinders for indexing in the manner accomplished in the machine shown in the co-pending application, Serial No. 646,737. In the present case, however, the work is not reciprocated vertically, relative movement between the work and the grinding element in a vertical direction being brought about

by a movement of the reciprocating head on which the grinding elements are supported, as will appear more fully hereinafter. The frame of the machine *a* carries fixedly a knee *a'* on which is supported for lateral movement away from the frame *a*, a slide *b* which itself supports the work table *c* which moves transversely of the slide *b* to carry the gear *d* across the front of the grinding elements. The gear *d* is supported on the work table *c* for a rolling movement by a shaft *d'* with the lower end of which is engaged Bilgram bands the ends of which may be anchored adjustably to the end walls of the slide *b*. The work table *c* is reciprocated transversely across the machine through power delivered from the main source *e* and telescoping shafting *e'*. The supporting slide *b* is throw out periodically so as to carry the work laterally away from the grinding element for indexing through a horizontally disposed pitman which is connected operatively to the slide *b* and to a slide in the frame *a* which permits uninterrupted transverse reciprocations of the work table but which when locked in its advanced position causes the table during succeeding reciprocations to be thrown away from the work and until such locking slide indicated at *b'* in Figure 2 is released.

All of the elements described are found in the same relation and perform the same functions in the machine shown in the co-pending case and are not shown in any greater details nor described with greater particularity since one skilled in the art is enabled to construct the same readily by reference to the disclosure in such copending case taken with the disclosure in the present case. The effect desired is that the work *b* with the work table *c* shall be constantly reciprocated transversely across the front of the machine and, periodically, thrown outward laterally away from the front of the machine for indexing. Rolling of the gear on its own axis accompanies, of course, the transverse reciprocations. The present machine, insofar as the description has proceeded, differs from the machine in the other application only in that the work is not reciprocated vertically.

Supporting hedd for the grinding elements and devices for imparting desired movements thereto.

The supporting head for the grinding elements in the improved construction is adapted to reciprocate vertically to carry the wheels across the work with a step by step movement and this head is angularly adjustable so that its movement may be along the line of the helix angle of the teeth to be ground. As shown, the head comprises a generally rectangular slide *f* mounted in ways along its opposite side edges formed with a supporting frame *g* which is mounted pivotally on the main frame *a* by a suitable spindle *g'*, the axis of which passes through the vertical axis of the work *d* and approximately through the mid point of the work so that angular movement of the frame *g* about its axis will be likewise angular movement substantially of about the point of grinding. This insures that the grinding wheels, as will later appear, will not be displaced bodily with respect to the work when the angular adjustment of the slide is changed. A most convenient way of adjusting the frame *g* with the slide is through a tooth sector *h* carried on the frame *a* and with which engages a pinion *i* carried with the frame *g* and rotatable along the teeth of the sector by suitable operating devices such as a handle crank *i'*, worm i^2 and worm wheel i^3 fastened with the spur pinion *i*. Other clamps *k* carried with the frame *g* may engage teeth of the sector to maintain the frame in adjusted position. Since the mounting of the grinding elements *l* will be described under a separate heading later, no other reference will be made to them at this point other than to point out that they are mounted on the sliding head *f* and are required to be carried back and forth along the surfaces of the teeth being ground. The slide *f* is supported in substantially a state of equilibrium by coiled springs *f'*, the upper ends of which seat in a cross-head f^2 connected with the slide and the lower ends of which seat on plungers g^2 which extend through the cross-head f^2 and are adjustably connected with a bracket g^3 secured to the frame *g*. Cylinders f^3 enclose the springs *f'* and these cylinders are carried with the slide *f*. The function of the springs *f'*, generally speaking, is to counterbalance the weight of the slide to an extent which facilitates its upward and downward movement with minimum power.

The power means for automatically reciprocating the slide *f* with a step by step movement in order to carry the grinding wheels *l* across the work may be in all essential respects the same as the devices disclosed in said co-pending application for raising and lowering the work table. In the present case the slide *f* is shown as having a rearwardly extending arm f^4 which is supported on a vertical screw *m* which is threaded through a nut *m'* journaled suitably on the rear of the frame *g* and having exteriorly a bevel pinion m^2 engaged with a bevel gear m^3 which is rotated first in one direction and then in the other to effect the raising and lowering of the screw *m* with the slide *f*. The bevel gear m^3 may be rotated by a drive chain *n* which passes over a driving sprocket *n'* driven by a ratchet wheel n^2 operated in one direction or the other by one of two pawls n^3 re-

ciprocated, respectively by connecting rods n^4 pivoted to a rotating crank disk n^5 which in turn is rotated from the main power source e. The pawls are thrown into and out of operative engagement with the ratchet wheels automatically by stops which are susceptible of adjustment to insure this engagement at predetermined times with respect to each of the pawls so that not only will this slide f be moved in the desired direction but also moved in that direction during predetermined periods. The details of this mechanism appear at length in the said co-pending case and need not be repeated here since no claim is made to it apart from the combination disclosed. An idler n^6 for the chain n is shown as controlled by a hand-wheel n^7 all supported in a bracket a^2 on the main frame a.

Not only must the slide f be reciprocated in the manner just described but means must be co-ordinated therewith for throwing the work d laterally outward away from the grinding elements during predetermined transverse reciprocations of the work table c, for indexing. As was pointed out briefly hereinbefore the lock slide b' is the instrumentality by which this is accomplished in the manner described in the co-pending case. The control of this lock slide b' is effected by the sliding head f through an arm f^5 carried with it and adapted to engage limit stops o, o', on a rod o^2, which is connected through an oscillating disk o^3 and link o^4 with a rocker arm o^5 adapted to engage with the slide b' and reciprocated as required to perform its function. In the embodiment illustrated the arm f^5 is intended to engage operatively with two limit stops o, o', one at each extreme of its travel with the result that the slide b' is actuated at such times. Indexing, however, may be controlled by control of these limit stops as will be understood by one skilled in the art, having further reference to the construction shown in the co-pending case.

Operation.

With the description thus far given it will be understood that the work d is moved transversely of the grinding elements l by transverse reciprocations of the work table c, the work being rolled meanwhile on its axis by the Bilgram band engagement. During this transverse reciprocation the grinding wheels are carried along the teeth of the work by being raised or lowered bodily with the slide f under power delivered through the chain n and screw m. At predetermined times, the work is to be indexed by any suitable means such as are illustrated in the co-pending application and this indexing is done during a period of time when the work is disengaged from the grinders by carrying it laterally away therefrom. This movement away from the grinders is controlled by the tripping mechanism carried with the reciprocating slide f and connected operatively through the arm f' to the throw out slide b', the function of which is to cause the slide b to be moved outwardly from the frame a during one of the transverse reciprocations of the work table c, all as described in the co-pending case. The essential setting of the head f is through manual operation of the crank arm i' whereby the frame g is moved angularly about its axis g' until the slide assumes an angular position equal to the angle of the helix on which the teeth of the work d^2 are formed.

Supporting means for the grinding elements and adjustments therefor.

Referring now to Figures 6 and 7 particularly the slide f has supported on its axis separate brackets p, p', which support the respective grinding wheels and are themselves adjustable separately for elevation within the main slide. On the face of the slide are also supported driving motors l', l', for the respective grinding wheels, the power being communicated in any convenient way as by belts l^2 engaging with the spindles of the respective wheels l. Referring now to the bracket p in Figure 7 it will be seen that it is carried on an undercut slide p^2 which moves in vertical ways cut in the main slide f. Clamping bolts p^3 engage the bracket p and slide p^2 operatively to the end that this slide may be clamped in its ways against movement by setting up on the nuts p^4 at the exposed ends of the bolts. An adjusting screw q passes upwardly through the lower end of the main slide f or some part carried therewith and is engaged with the lower edge of the slide p^2 so that the vertical height of the latter may be accurately adjusted with respect to the main slide f and through it the vertical height of the supporting bracket p of one of the wheels l. The other bracket p' is similarly and independently adjustable within the main slide f. From the description given it will be evident that wheels l with their spindles may be separately adjusted to any relative height although the spindles will lie in parallel planes, that is to say, the grinding surfaces of the wheels themselves will be maintained in parallel planes. In practice, in grinding two teeth of a helical gear simultaneously it is desirable that one wheel be displaced at a distance above the other wheel so that the two wheels will be brought simultaneously into engagement with the surfaces to be ground and will complete their grinding simultaneously. Since the wheels move along the helix angle it will be evident that the amount of relative displacement required initially will depend on the helix angle since if in the extreme case

the helix angle became zero, as would be the case in spur gear, the two wheels would not be displaced relatively at all but their axes would be in the same horizontal plane. In fact, this is the case indicated in Figure 3 where the reciprocating head is vertically disposed. As shown in Figure 1, however, the helix angle appears to be substantially 45° in which case one wheel l is displaced appreciably above the other wheel longitudinally of the slide f, the two axes of the wheels, however, lying in parallel planes.

On the brackets p, p', for the two wheels may be supported fixedly trimming devices indicated at r which may be formed as diamonds carried on bell crank levers adapted to be swung on their axes to bring the diamonds across the grinding faces. Movement of the respective wheels into engagement with the diamonds may be accomplished by operation of the hand wheels s which control slides in which the wheel spindles are journaled, and which slides are supported on the brackets p, p'.

Changes in many of the details of construction may be made by one skilled in the art without the exercise of the inventive faculty and without departing from the spirit or scope of the appended claims.

What I claim is:—

1. In a gear grinding machine in combination with a grinding element, a work carrying slide movable transversely across the grinding element, means to move the grinding element as well as the work relatively along the tooth line of the work, and means to adjust the angular relation between the grinding element and work to vary the character of such line of movement.

2. In a gear grinding machine in combination with a grinding element, a work carrying slide movable transversely across the grinding element, a reciprocating slide to support the grinding element, and means to adjust the angular position of said slide.

3. In a gear grinding machine in combination with a grinding element, a work carrying slide movable transversely across the grinding element, a slide on which the grinding element is supported, a frame in which the last named slide is supported, and means to adjust the frame angularly with respect to the work.

4. In a gear grinding machine in combination with a grinding element, a work carrying slide movable transversely across the grinding element, a slide on which the grinding element is supported, a frame in which the last named slide is supported, means to adjust the frame angularly with respect to the work, and means to reciprocate the last named slide in the frame.

5. In a gear grinding machine in combination with two grinding elements, a work carrying slide movable transversely across the grinding elements, a slide on which the grinding elements are supported, and means to adjust the angular position of the slide with respect to the axis of the work.

6. In a gear grinding machine in combination with two grinding elements, a work carrying slide movable transversely across the grinding elements, a slide on which the grinding elements are supported, means to adjust the angular position of the slide with respect to the work, and means to move the grinding elements on the slide with respect to one another.

7. In a gear grinding machine in combination with two grinding elements, a work carrying slide movable transversely across the grinding elements, a slide on which the grinding elements are supported, means for turning each element with respect to the work and means carried on the slide to displace the axes of the grinding elements relatively while maintaining them in parallelism.

8. In a gear grinding machine in combination with the grinding element, a work carrying slide movable transversely across the grinding element, a slide on which the grinding element is supported, a frame in which the slide is supported, and means to support the frame for angular movement about an axis passing substantially through the point of grinding.

This specification signed this 23 day of May A. D. 1924.

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