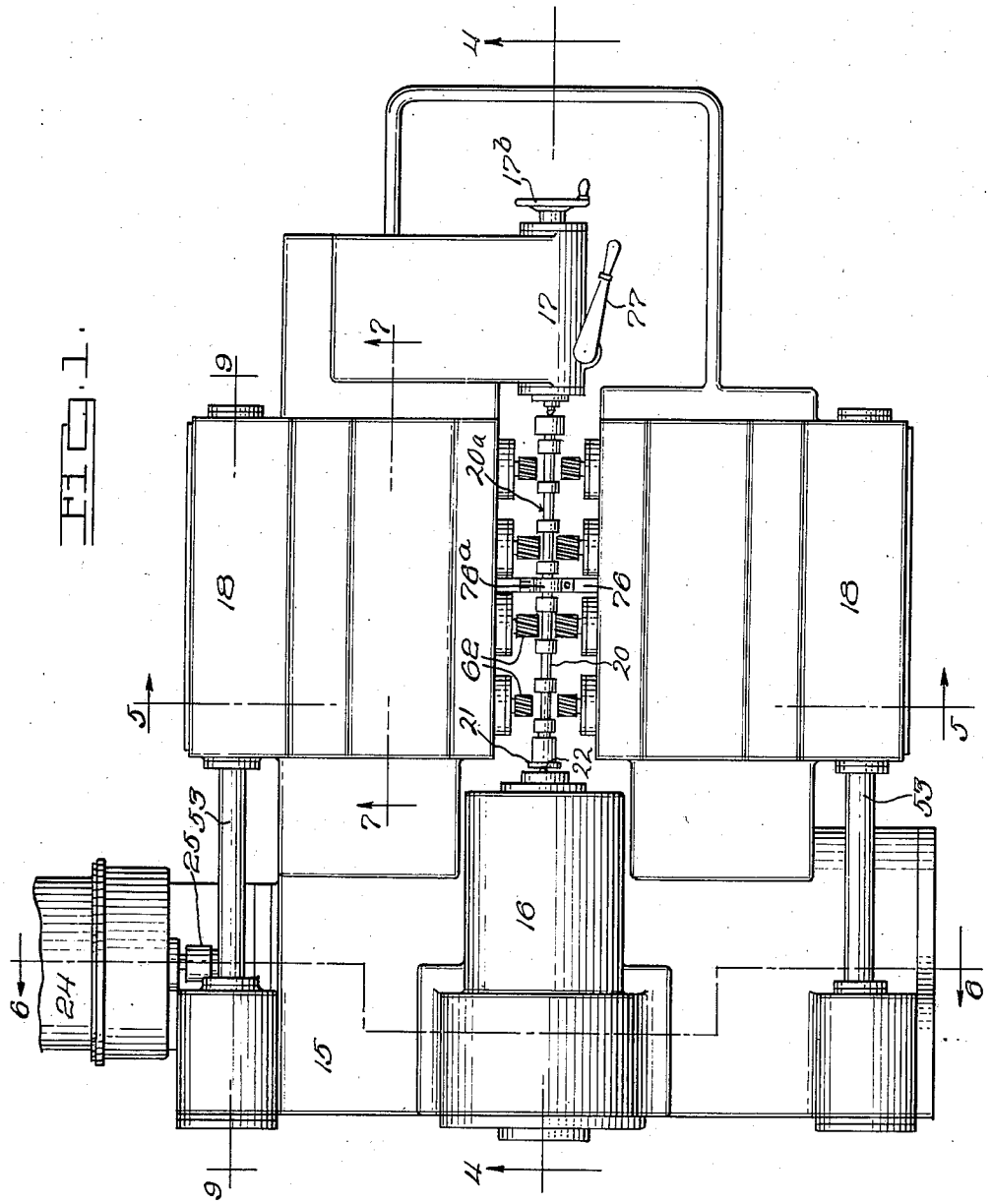
Jan. 22, 1935. W. SINCLAIR 1,988,520

MILLING MACHINE FOR CAM SHAFTS AND THE LIKE

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FIG. 1.



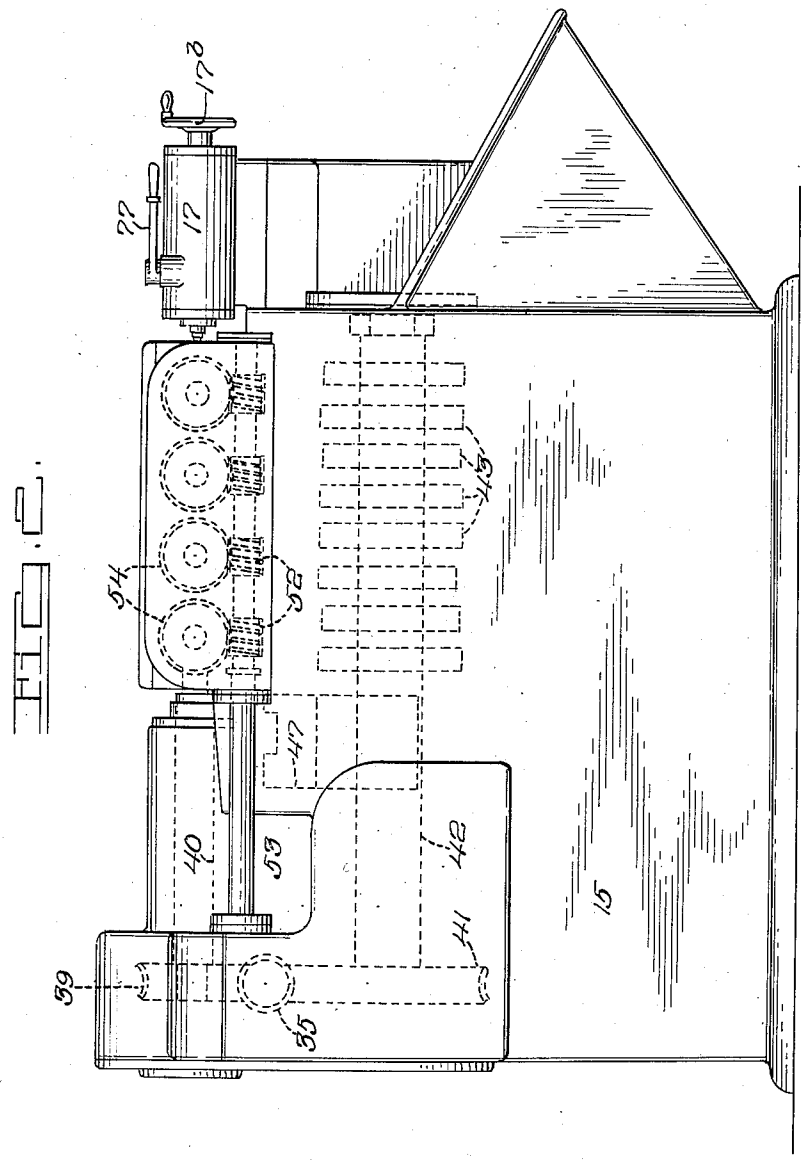
INVENTOR
William Sinclair
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MILLING MACHINE FOR CAM SHAFTS AND THE LIKE

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FIG. 2.



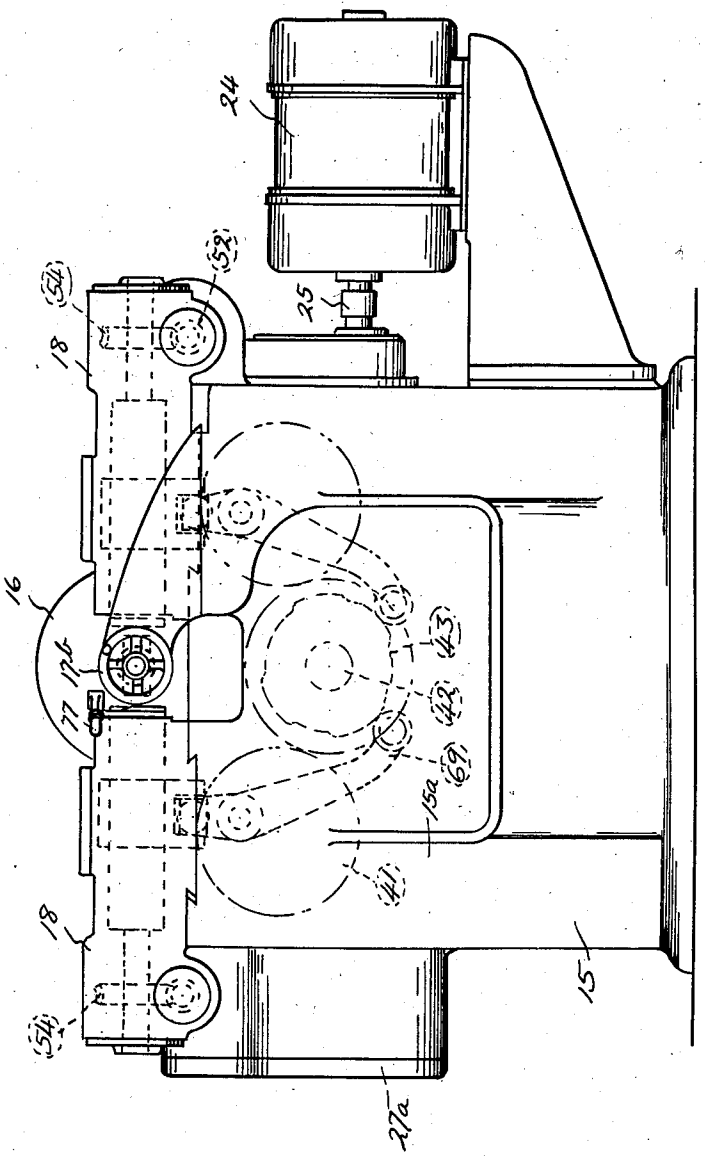
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MILLING MACHINE FOR CAM SHAFTS AND THE LIKE

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Fig. 5.



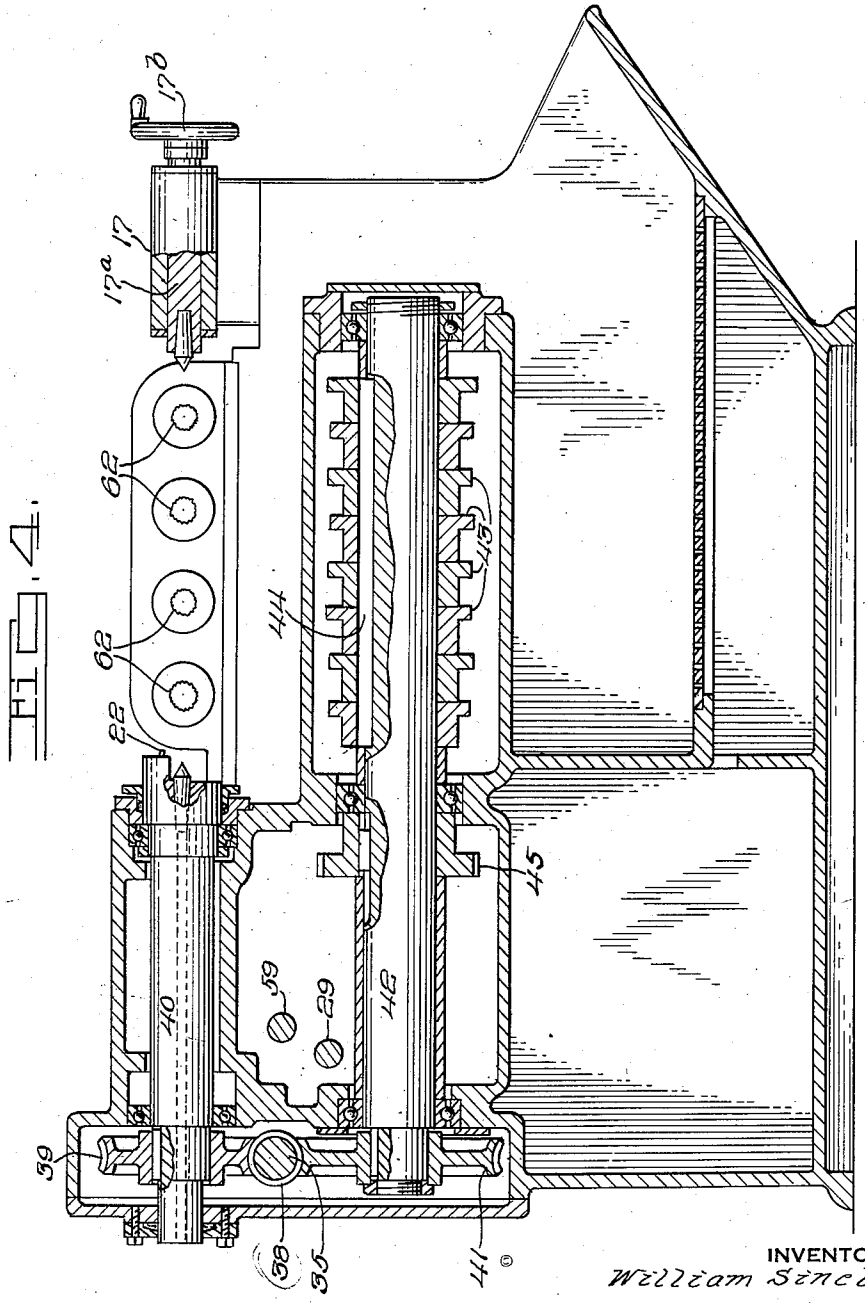
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FIG. 4.



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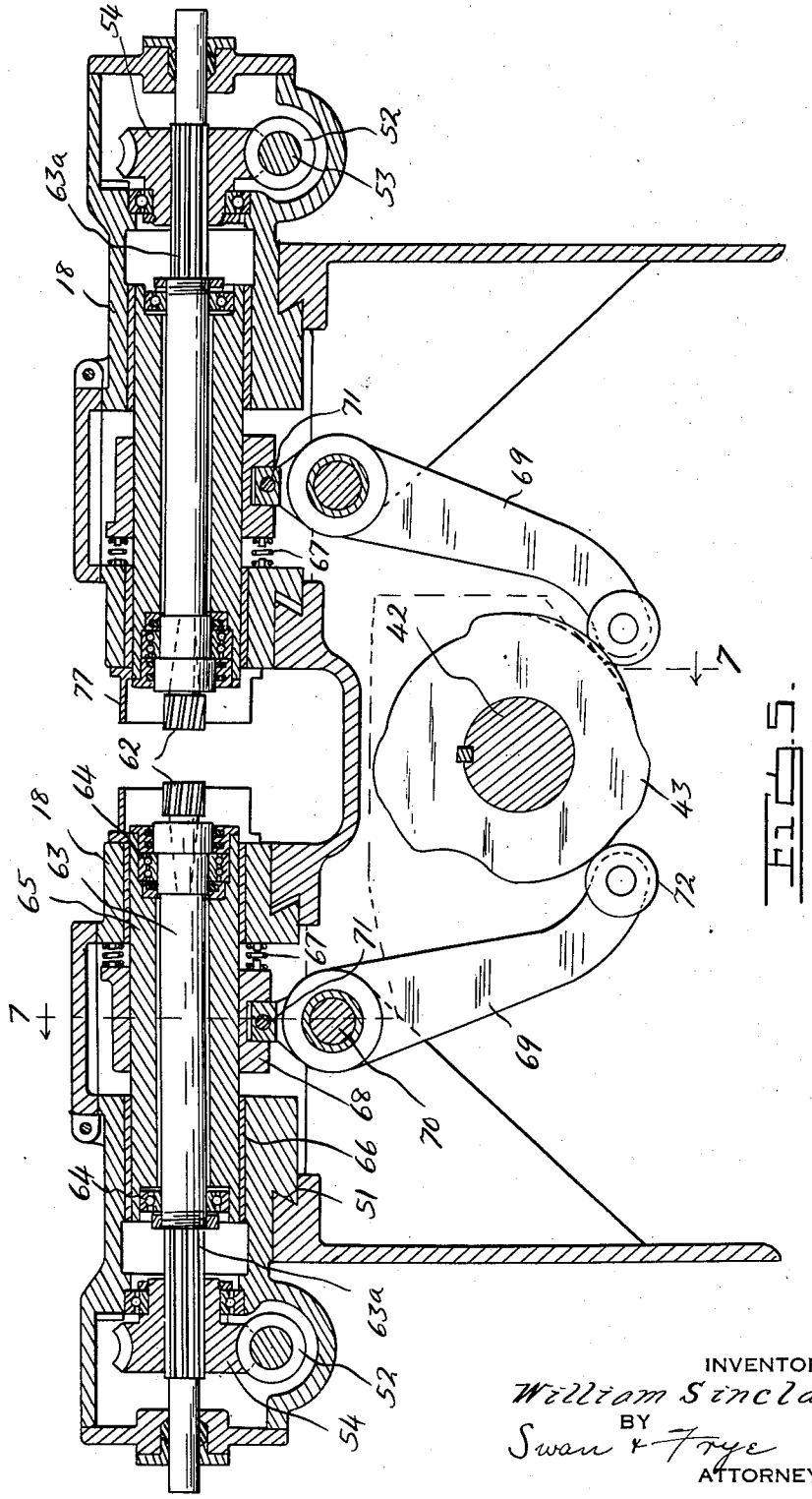


FIG. 5.

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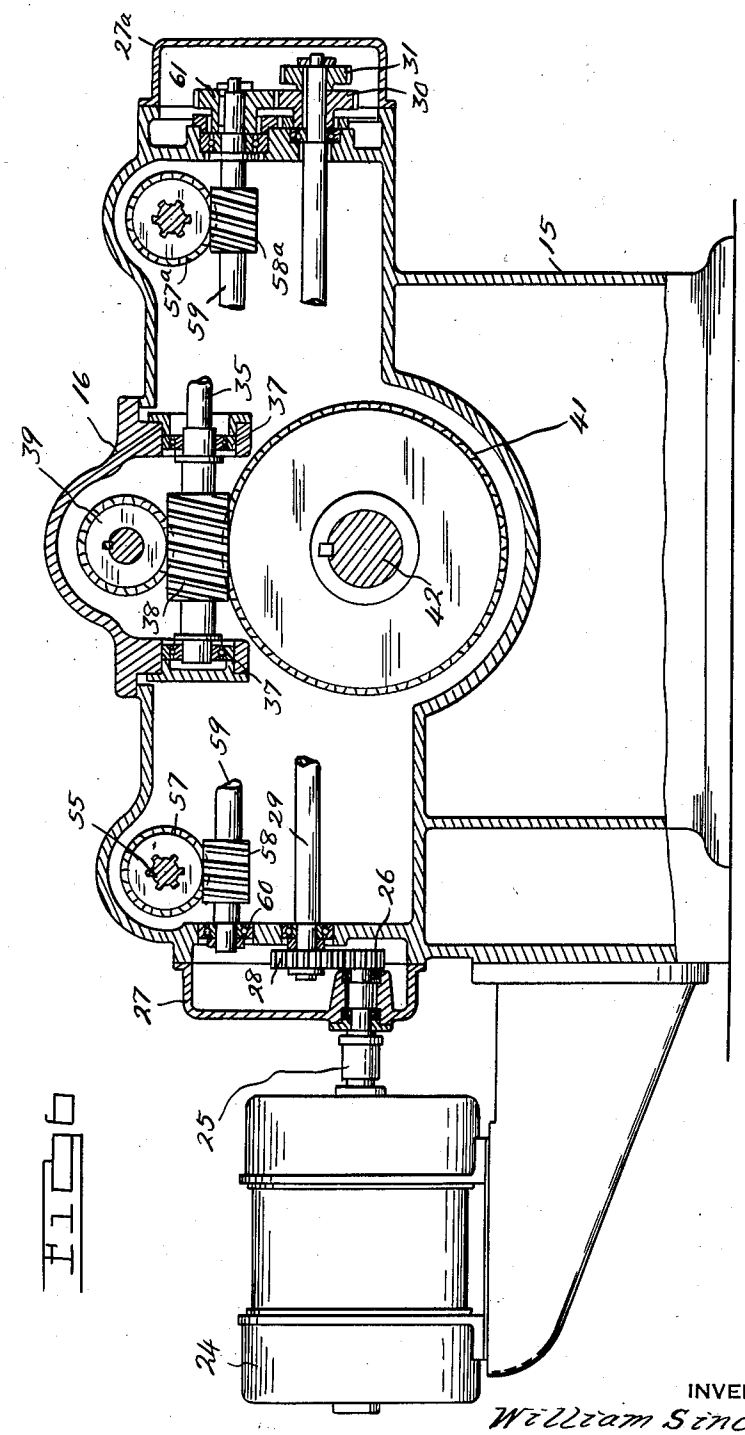


Fig 6

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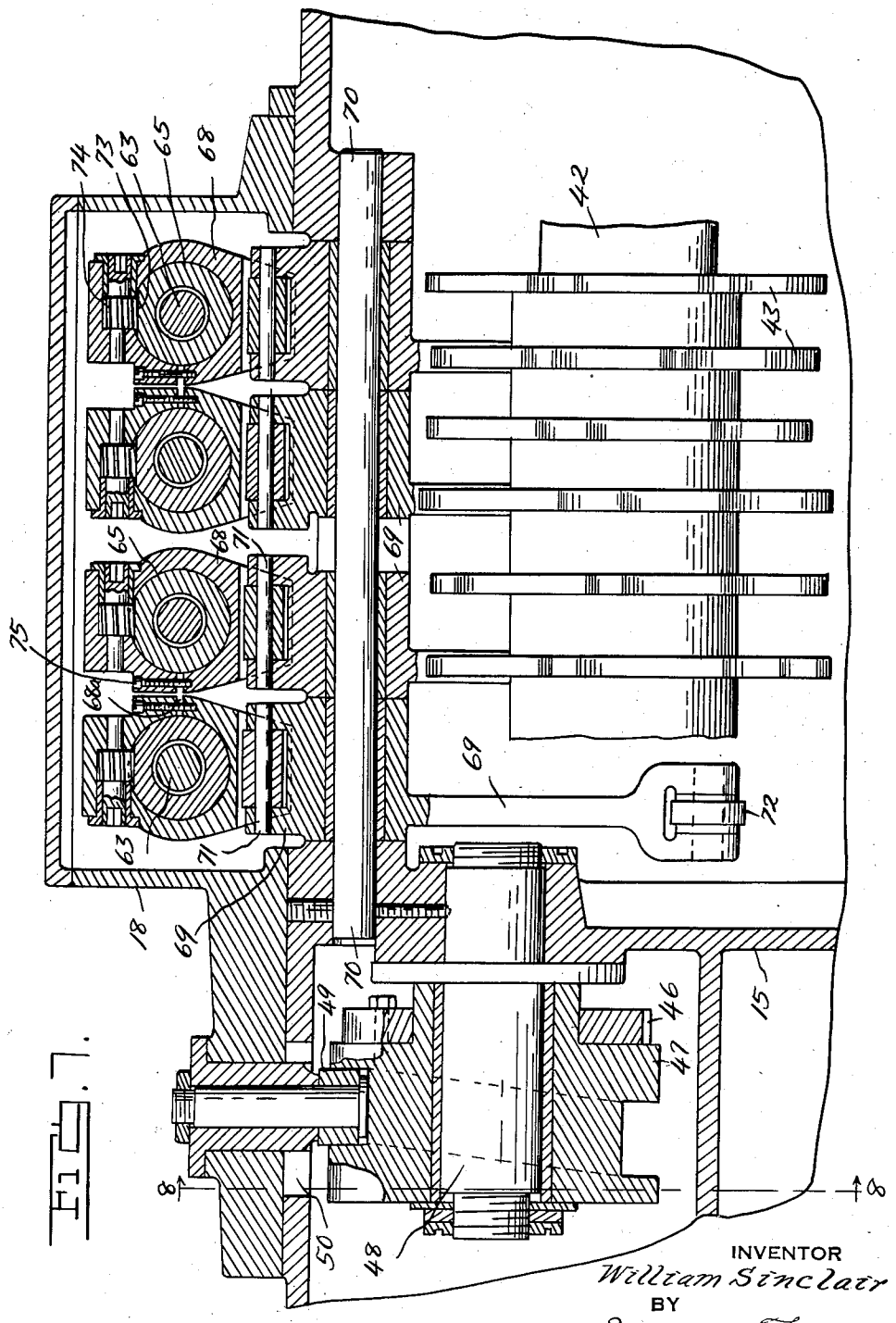


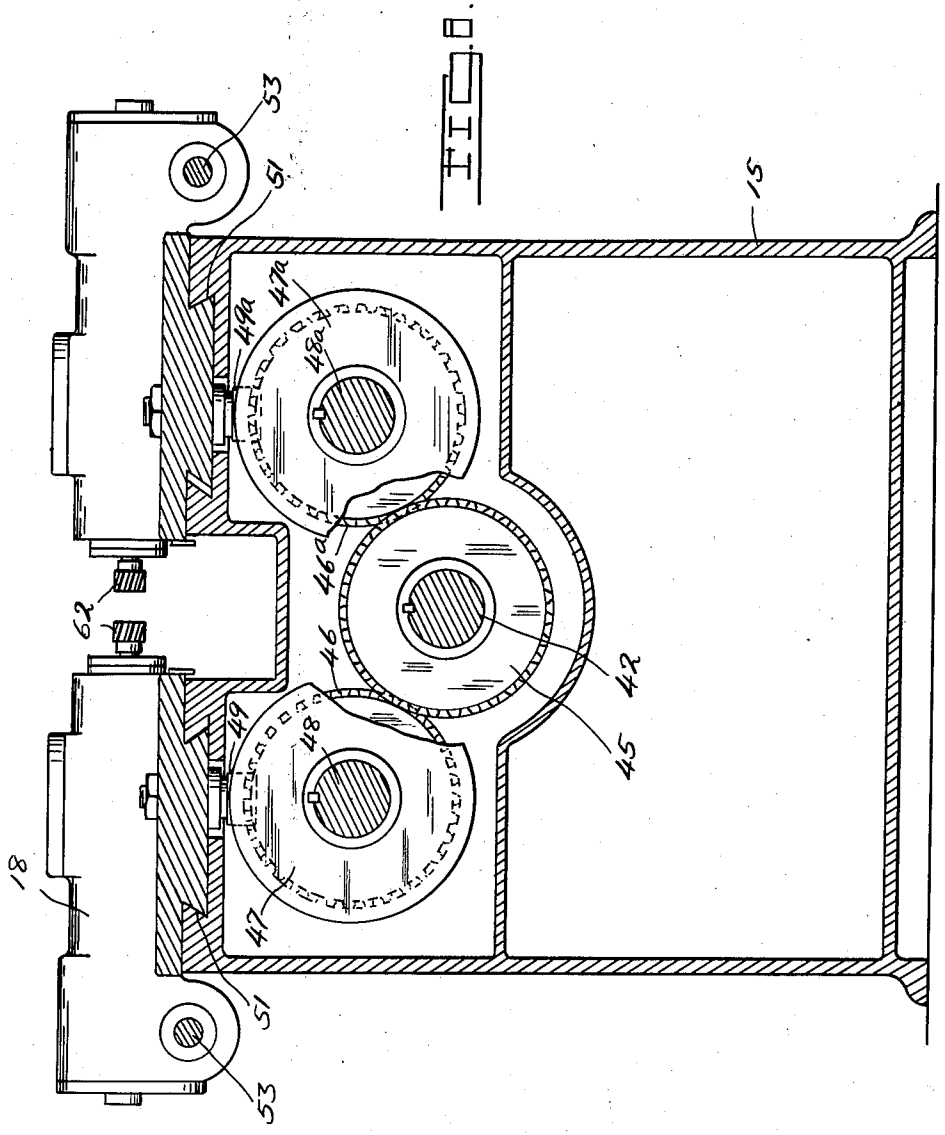
FIG. 7.

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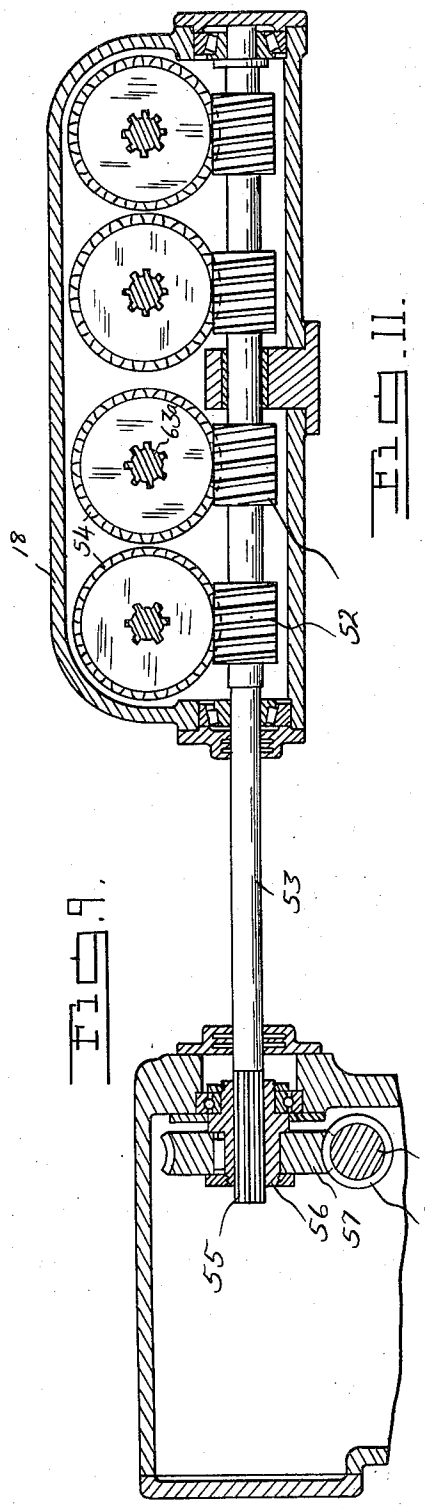


Fig. 9.

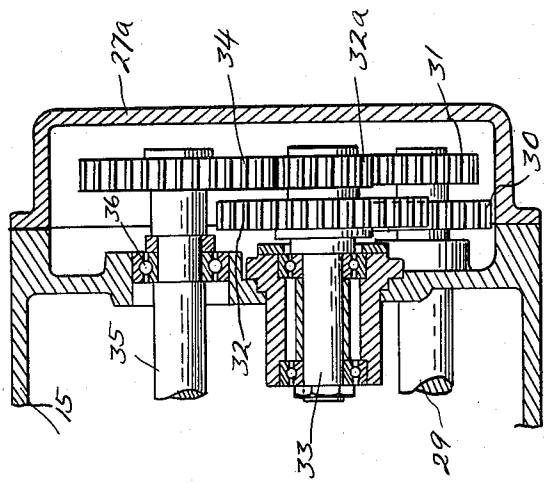


Fig. 11.

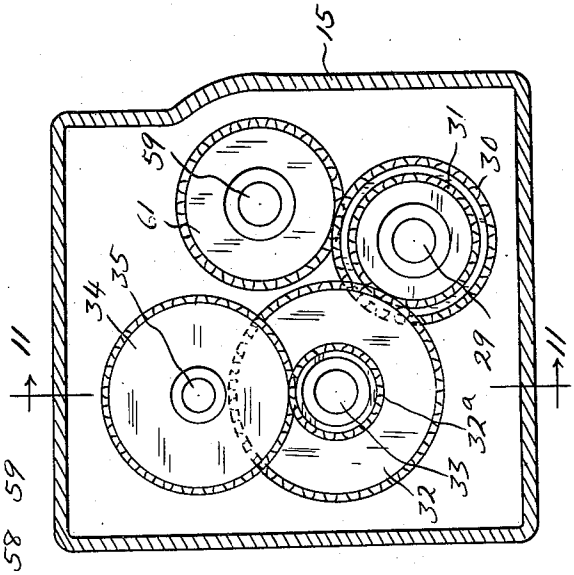


Fig. 10.

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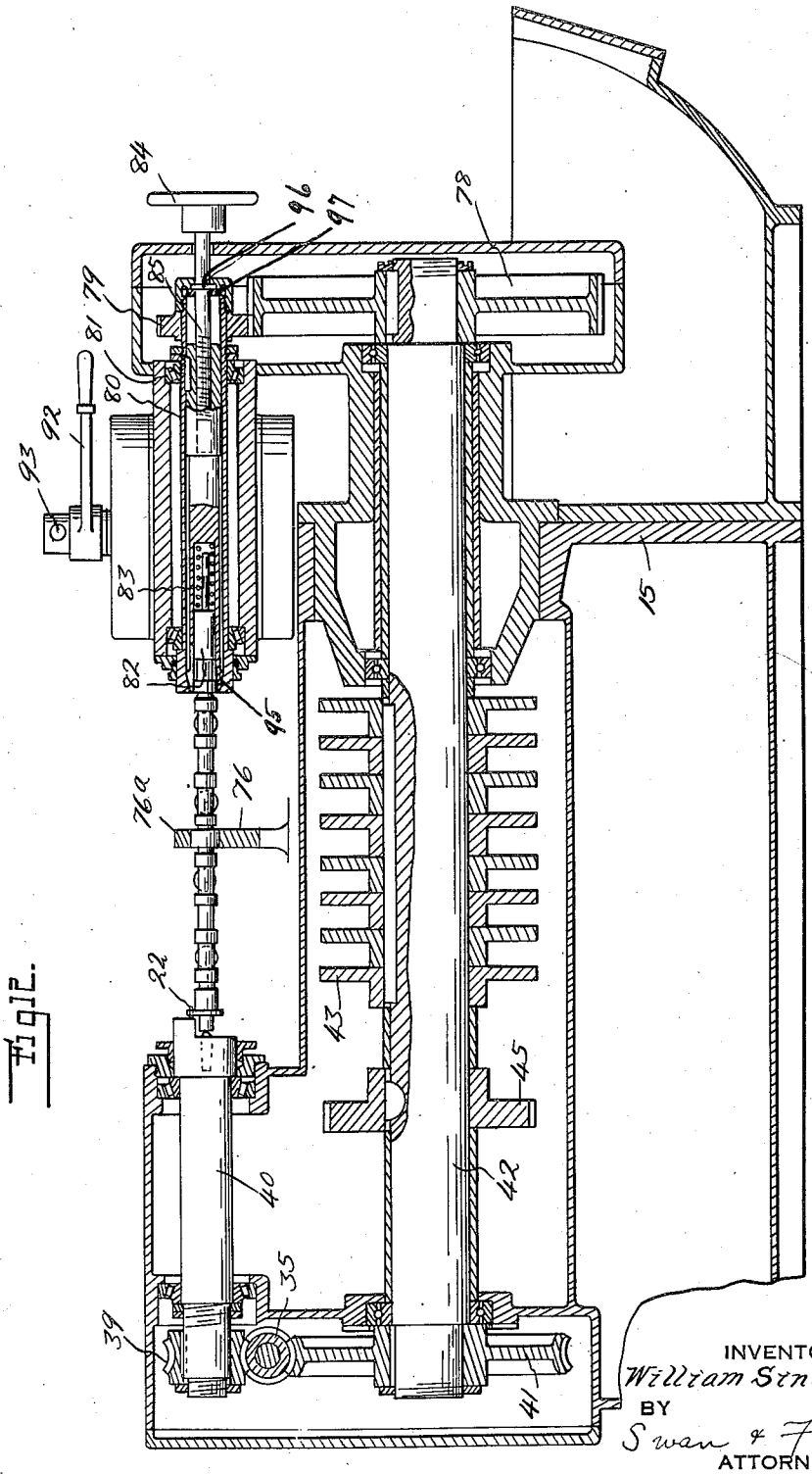


Fig 12.

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MILLING MACHINE FOR CAM SHAFTS AND THE LIKE

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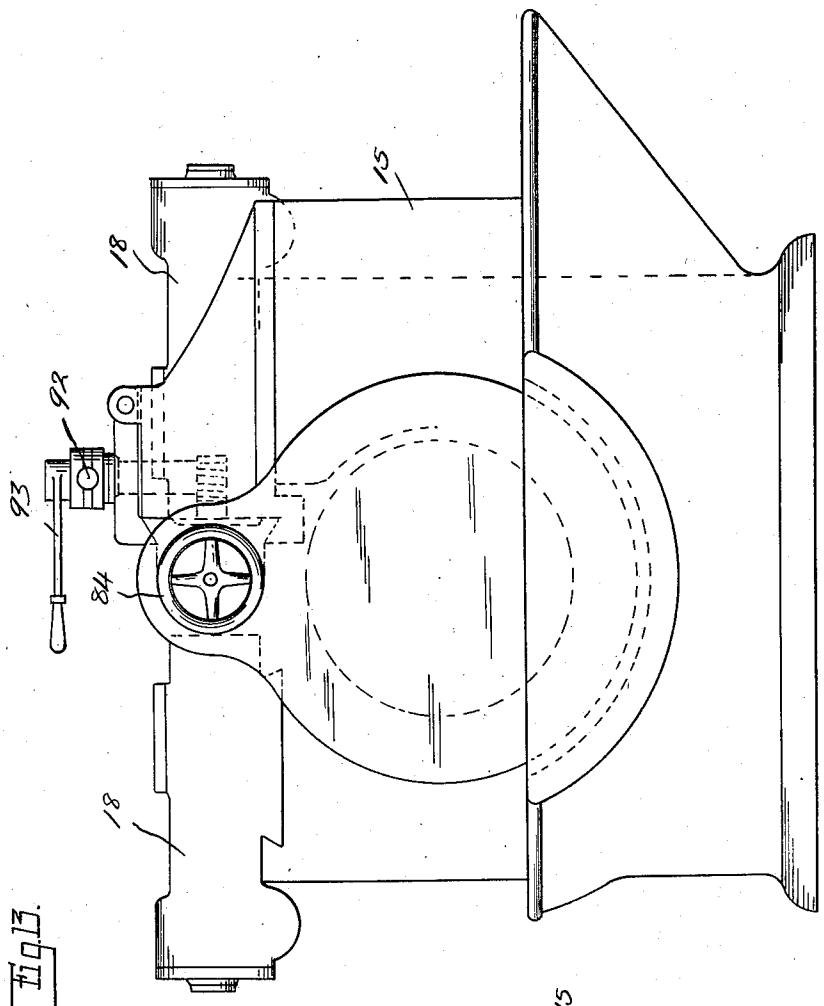


Fig. 13.

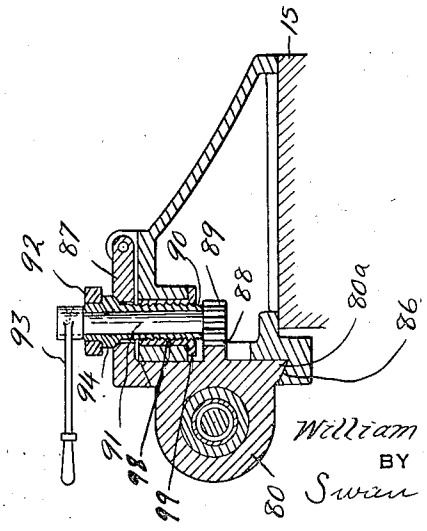


Fig. 14.

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Patented Jan. 22, 1935 1,988,520

UNITED STATES PATENT OFFICE

1,988,520

MILLING MACHINE FOR CAM SHAFTS AND THE LIKE

William Sinclair, Detroit, Mich., assignor to Production Engineering Company, Detroit, Mich., a corporation of Michigan

Application March 31, 1930, Serial No. 440,320

9 Claims. (Cl. 90—13.4)

This invention relates to milling machines, and more particularly to machines for milling the profiles of cams or other irregular shapes.

One of the objects of the present invention is the provision of a machine that will simultaneously mill all of the cam profiles on a multiple cam shaft or like article, whereby a comparatively quick profiling operation is secured on the entire cam shaft instead of necessitating a series of operations on the several cams.

Another object of this invention is the arrangement of a machine having a pair of heads mounted for controlled sliding movement longitudinally of the machine, and each head carrying a plurality of spaced milling cutters mounted for controlled individual movements laterally of the machine during the sliding movements of the heads.

A further object of this invention is the provision of simple drive mechanism for driving the mechanism for rotating the cam shaft being milled, the several milling cutters and the control mechanisms whereby the heads are slidably moved and the individual millers advanced or retracted.

Other objects and advantages will be apparent from the following description wherein reference is made to the accompanying drawings showing preferred embodiments of my invention, and wherein similar reference numerals designate similar parts throughout the several views.

In the drawings:

Figure 1 is a plan view of my improved machine with a cam shaft in position for milling.

Figure 2 is a side elevation thereof, with some of the interior mechanism shown in dotted lines.

Figure 3 is an end elevation, from the tailstock end.

Figure 4 is a central longitudinal section through the machine with the cam shaft removed therefrom.

Figure 5 is an enlarged vertical cross section taken substantially on the line 5—5 of Figure 1, looking in the direction of the arrows.

Figure 6 is a similar cross section taken substantially on the line 6—6 of Figure 1.

Figure 7 is an enlarged longitudinal detail sectional view taken substantially on the line 7—7 of Figure 1.

Figure 8 is a vertical section taken substantially on the line 8—8 of Figure 7.

Figure 9 is a longitudinal vertical section taken substantially on the line 9—9 of Figure 1.

Figure 10 is a vertical detail view showing the mounting of the shafts and pick-off gears in the gear box diametrically opposed to the motor mounting in Figure 3, the cover of the gear box being removed.

Figure 11 is a vertical sectional view taken substantially on the line 11—11 of Figure 10.

Figure 12 is a central vertical section through a modified form of my machine wherein the work is simultaneously driven from both ends.

Figure 13 is an end view thereof from the tailstock end, and

Figure 14 is a detail vertical view through the means for clamping and adjusting the position of the tailstock.

Referring now to the drawings, the numeral 15 designates a base of suitable size and contour, which, as herein shown, is arranged to support the head stock 16, the tail stock 17, and a pair of spaced slidable heads 18, each of which carry a plurality of milling cutters, as hereinafter pointed out. The head stock 16 is utilized in the embodiment shown in Figures 1–11, inclusive, as the driving element for the work being milled, as for example, the cam shaft 20 shown in Figure 1. The cam shaft is provided with a flange 21 adjacent one extremity, and, for driving purposes herein, this flange is apertured at a distance from the center of the shaft, a pin 22 suitably located on the head stock being adapted to fit into such aperture and rotate the cam shaft when the head stock rotatable elements are being driven. The cam shaft 20 is usually preliminarily machined to some extent before being profiled in my improved machine, as for example, the ends of the shafts being machined and scored at the centers for location on my improved milling machine, and in addition the center bearing of the cam shaft is machined to also aid in location herein. In addition the material between the several cams 20^a might be ground out or otherwise machined to clear the side faces of the several cams.

The mechanism for driving the head stock 16 will now be described, and at the same time the coaction between such mechanism and the remaining driving mechanisms will be pointed out. A single motor 24 is mounted on a bracket at one side of the machine bed and its shaft is connected through the flexible coupling 25 (note Figure 6) with the pinion 26, suitably journaled in bearings on the removable cover plate 27. The pinion 26 meshes with a pinion 28 at one extremity of the elongated shaft 29 which extends completely across the framework of the machine and carries adjacent its opposite extremity a pair of pinions 30 and 31 respectively. (Note Figures 6 and 11.) The pinion 31 meshes with a pinion 32

mounted on a stub shaft 33 (note Figure 11), and the pinion 32 meshes with the gear 34 fixed at one extremity of the shaft 35, which is mounted in bearings 36 in the framework 15 and is also mounted in a pair of bearings 37 in the head stock 16 (note Figure 6). Between the bearings 37 the shaft 35 carries a worm pinion 38 which meshes with a worm gear 39 keyed on the rotatable arbor 40 of the head stock (note Figure 4) to thereby turn this portion of the head stock to drive the cam shaft or other work then being milled. The worm pinion 38 also meshes with a larger worm gear 41 (note Figures 4 and 6), which is keyed on the shaft 42, suitably journaled in spaced bearings in the framework 15 longitudinally of the machine and below the work being milled. The shaft 42 is adapted to receive a plurality of master cams 43, each fashioned to properly control the movements of a milling cutter, as hereinafter described, the master cams being keyed upon the shaft 42, as by the elongated key 44, and positioned longitudinally of the shaft in any suitable manner. On the shaft 42 is also keyed a spur gear 45 (note Figures 4 and 8) which meshes with a pair of gears 46 and 46ª, respectively, bolted or otherwise secured at one extremity of the cam-slotted drums 47 and 47ª (note Figure 7). The slotted drums 47 and 47ª are mounted to revolve on stub shafts 48 secured in the framework of the machine at either side of the head stock, and the peripheral cam slots in such drums receive pins 49 and 49ª extending through elongated slots 50 in the framework of the machine and secured at their upper extremities in the slidable cutter heads 18, which, as best shown in Figures 7 and 8, are slidably mounted in dovetail slots 51 extending longitudinally of the machine. The slots in the cam drums 47, 47ª, may be suitably shaped and positioned to reciprocate the slidable heads 18 in any desired manner, as for example to slide the cutter head slowly in one direction for a major portion of the cam slot and then rapidly return the head to its original position. In actual use it is preferred that one head 18 be slid in one direction during the profiling operation on the cam shaft while the other head is being slid in the opposite direction, and both are rapidly returned to their initial positions.

In each slidable cutter head 18 are arranged a plurality of milling cutter mechanisms, as best shown in Figures 1, 4 and 9, simultaneously driven by means of a plurality of worm pinions 52 splined on an elongated shaft 53 and meshing with worm gears 54 mounted on the cutter-carrying shafts (note Figures 9 and 2). The shaft 53 is journaled in spaced bearings in the slidable cutter head 18 and at its forward extremity is provided with a multiple-splined portion 55 slidably fitted within the hub 56 of the worm gear 57, which meshes with the worm pinion 58, keyed or otherwise suitably secured on the elongated shaft 59, which extends laterally across the framework of the machine and is journaled at its ends in suitable bearings 60 (note Figure 6). The cutters in the other slidable head 18 are similarly constructed and driven from the shaft 59 by a worm pinion 58ª meshing with the worm gear 57ª. Adjacent one extremity of the shaft 59 is mounted the pinion 61, which meshes with the pinion 30 on the shaft 29 directly connected with the motor shaft through the pinions 26 and 28 (note Figures 6 and 10).

It will accordingly be apparent that from the single motor 24 driving mechanisms are suitably connected whereby the head stock 16 is rotated at a desired speed, the master cam shaft 42 rotated at a slower speed (note the differences in size of the worm pinions 39 and 41 in Figures 4 and 6) the slidable heads 18 are reciprocated through the cam drums 47, 47ª and simultaneously the milling cutters are rotated at appropriate speeds. Such driving mechanisms are compactly arranged in the embodiment illustrated in Figures 1–11 at one extremity of the machine head 15. Moreover, the pinions 26, 28, 30, 31, 32 and 34 are mounted adjacent the extremities of their respective shafts so that they can be readily removed from the shafts and replaced by pinions with different numbers of teeth or the like, in the manner of pick-off gears. Such pinions are normally enclosed by cover plates, as the cover plates 27, 27ª in Figures 6 and 11. Accordingly, any desired changes in speed of certain of the shafts relatively to other shafts may readily be obtained.

The tail stock 17 is mounted in longitudinal alignment with the head stock 16 and includes a longitudinally movable member 17ª, which may be moved toward or from the head stock upon rotation of the hand wheel 17ᵇ through suitable mechanism, in the usual manner of tail stocks.

The milling cutter mechanisms are best shown in Figures 5 and 7. The cutters 62 are removably mounted at the inner ends of the shafts 63 in any suitable manner, and the shafts 63 are mounted for rotation in spaced bearings 64 in slidable quills 65, which as best shown in Figure 5, are mounted for sliding movement in bushings 66 in the heads 18. The quills 65 are normally pressed outwardly away from the work being milled by means of a plurality of coil springs 67 arranged between a portion of the head 18 and a collar 68 carried by the quill. The shaft 63 is provided with a multiple-spline 63ª which interfits with the hub of its worm pinion 54 whereby the sliding of the quill may be effected during the continued rotation of the shaft 63 and its attached milling cutter 62. The sliding movement of the quill is herein shown as controlled from the master cams 43, an arm 69 being pivoted between its ends on the shaft 70 and connected adjacent one extremity with the collar 68 of the quill, as by the pivot pin 71. The other extremity of the arm 69 carries a roller 72 which bears against the periphery of the master cam 43 cooperating therewith. The springs 67 serve to maintain the roller 72 in constant contact with the surface of the master cam 43 through pressing outwardly on the collar 68 to which one extremity of the arm 69 is pivotally secured.

As best shown in Figure 7, provision may be made for initially adjusting the position of the milling cutter 62 relatively to the work being milled. As herein shown, the quill 65 is formed with a rack portion 73 which meshes with the pinion 74 suitably mounted in the upper portion of the collar 68, so that rotation of the pinion 74 will slide the quill 65 relatively to the collar 68 whenever the collar is loosened from the quill. To permit ready loosening and clamping of the collars 68 upon the quills 65, whenever desired, I have shown in Figure 7 each collar 68 provided with one of its sides split, as by the horizontal slot 68ª, and then provide an elongated shoulder bolt 75 threading into the portion of the collar below the slot, whereby rotation of the bolt in one direction will serve to tend to close the slot 68ª and thereby firmly clamp the collar 68 upon the quill 65, while rotation of the bolt in the opposite direc-

tion will serve to loosen the collar and free the quill for longitudinal adjustment as desired.

The operation of my improved machine is believed to be apparent. Assume that it is desired to profile the cams on the cam shaft of a four-cylinder motor, which shaft 20 has been preliminarily machined between the cams and to provide end and center bearings. The ends of the shaft are also preliminarily scored at their centers, while the flange of the cam shaft is provided with an aperture radially offset from the center of the shaft. The cam shaft is then positioned into the machine, by withdrawing the tail stock 17, then placing the scored center of one end of the shaft against the pointed center of the head stock rotating element 16 and then guiding the cam shaft flange so that its aperture fits snugly over the projecting pin 22 on the head stock 16. The central bearing of the cam shaft is then lowered into engagement with the lower half of the bridge bearing 76, whereupon the tail stock 17 is advanced by turning the hand wheel 17^b to bring the pointed center of the tail stock into the scored center at the adjacent end of the cam shaft. The hinged cover 76^a is then swung over the center bearing of the cam shaft. This operation of inserting the cam shaft to be milled is quite simple in practice and the rotating head stock and other mechanisms of the machine need not be stopped to either withdraw the finished cam shaft or insert a new one. The locating of the pin 22 on the head stock into the aperture of the cam flange is readily done by a "feeling" operation after the scored center of the cam shaft end is placed upon the pointed center of the head stock. The outward and inward movement of the tail stock is also quickly secured by spinning the hand wheel 17^b, while the semicircular cup on the bridge bearing 76 for the center bearing of the cam shaft provides a ready means for guiding the cam shaft after the pin 22 has been inserted in the aperture in the cam shaft flange and the cam shaft accordingly rotated. Moreover, this bearing 76 so holds the rotating cam shaft that the pointed center of the tail stock accurately seats in the scored center of the adjacent end of the cam shaft. The milling cutters 62 are normally moved laterally away from the work, and accordingly do not interfere with the removal of a finished cam shaft or the insertion of a new one, but in an effort to safeguard the workmen, I preferably provide guards 77 in spaced relation around the upper portions of the milling cutters while they are in their outermost positions (note Figure 5).

After the master cams 43 have been secured in proper relation upon the shaft 42, the profiling operation of the several cams on each cam shaft 20 is substantially automatic. The shaft 42 carrying the master cams 43 is geared for simultaneous rotation from the same shaft that drives the head stock and work to be milled. The contours of the master cams regulate the lateral movements of the milling cutters 62, through the sliding movements of their quills 65 as the pivoted arms 69 are swung by the master cams. Simultaneously the several milling cutters are being rotated at desired speeds through the shafts 53, and the heads 18 carrying the milling cutters are reciprocated longitudinally of the machine through the grooved cams 47 and associated mechanism. Preferably one of the heads 18 is slid toward the head stock from the initial position shown in Figure 1 to thereby mill the profiles of the cams at the right of the milling cutters in Figure 1, and the other head 18 slid toward the tail stock to thereby mill the profiles of the cams at the left of the milling cutters in Fig. 1. Accordingly, all of the eight cams shown on the cam shaft 20 in Figure 1 will be simultaneously milled. The sliding movements of the heads 18 are controlled by proper proportioning of the cam grooves in the drum 47, and I prefer a slow, sliding movement of the head during the profiling operation, followed by a comparatively rapid return, though other arrangements may be made to suit the conditions of the work being milled. If desired, the rotating parts may be automatically stopped after the completion of the profiling operation on each cam shaft or other work and the work removed and replaced while the rotating mechanism is stopped. However, by properly timing the removing and replacing operation with the return of the milling cutters to original position by the grooves in the cam drum 47, I am enabled to keep the rotating elements in constant motion for long periods of time. In Figures 12 and 14, inclusive, I have shown an embodiment of my invention that is particularly useful with cam shafts that are of comparatively greater length and relative slenderness, such for example as the cam shaft for eight cylinder engines. In this embodiment, I drive both ends of the work being milled, and as herein shown, the connection for driving the tail stock is from the shaft 42 carrying the master cams 43 and pinion 45 in my first described embodiment. The shaft 42 is made of requisite thickness and strength to accommodate driving the tail stock of my improved machine, and adjacent its opposite ends it carries the worm gear 41 and the spur gear 78 (note Figure 12). The gear 78 is comparatively wide and meshes with the narrower pinion 79 secured on the rotating portion of the tail stock 80, which is mounted in suitable bearings 81 in the framework of the machine. The forward extremity of the tail stock is herein shown as provided with a recess for the reception of a spring-pressed plunger 82, which is maintained by the coil spring 83 normally beyond the remainder of the tail stock except when in engagement with the work to be milled. This plunger 82 is within the hollow center of a spring collet 95 (note Figure 12) having inclined outer surfaces on its spaced jaws which cooperate with the tapered forward extremity of the barrel portion 80 of the tail stock, so as to firmly grip the adjacent cam extremity or other work to be milled in the usual manner of spring collets whenever the collet is thrust forwardly into engagement with the tapered forward extremity of the barrel. To move the spring collet longitudinally within the barrel as desired, I have provided the rear extremity of the collet with a central threaded aperture with which cooperates the threaded forward portion of the shaft 85, which carries at its rear extremity a hand wheel 84, and is provided intermediate its ends with a collar 96 which abuts against a washer 97 secured at the extremity of the barrel 80 so as to prevent traveling of the shaft 85 when the hand wheel is rotated. Accordingly whenever the hand wheel 84 is turned in one direction, its threaded portion will cooperate with the threaded portion of the collet so as to move the collet toward the rear extremity of the barrel 80, and so withdraw the spring jaws of the collet from engagement with the work being milled, while rotation of the hand wheel in the opposite direction will serve to advance the collet within the barrel 80 to again clamp the jaws about the

work. Meanwhile the spring-pressed plunger 82 will remain in contact with the end of the work and maintain the work in firm engagement with the head stock so as to maintain the apertured flange on the work in contact with the pin 22 on the head stock.

As best illustrated in Figures 12 to 14, I have also provided novel means for readily moving the tail stock longitudinally of the machine and clamping it in any adjusted position. In this construction the tail stock 80 is provided with a flared side portion 80^a fitting in a fixed dovetail groove 86 at its lower extremity and cooperating with a flared pivoted clamping member 87 at its upper extremity. The central portion of the side portion 80^a of the tail stock carries a rack 88 which meshes with a pinion 89 carried at the lower extremity of the vertical shaft 91, which is journaled in a hollow externally threaded sleeve 90 which sleeve threads within an internally threaded bushing 98 fixed within an aperture in the frame work and provided with a bottom flange 99 arranged to prevent upward travel of the bushing when the sleeve 90 is rotated. The upper extremity of the sleeve 90 is provided with a polygonal portion about which fits the hub of a handle 92, and just below such polygonal portion the sleeve is provided with an outwardly flanged portion having a rounded lower edge which fits within a recess in the pivoted clamping member 87. The vertical shaft 91 carries a handle 93 at its upper extremity in any suitable manner.

By virtue of this construction, when the handle 92 on the sleeve is partially rotated the sleeve rides upwardly within the bushing 98, releasing the pressure formerly exerted upon the clamping member 87 through the flange 94 of the sleeve. With the pivoted clamping member 87 thus loosened from the tail stock rotation of the shaft handle 93 will rotate the pinion 89, and through the rack 88 will cause the longitudinal movement of the tail stock. When the desired new position of the tail stock has been reached the sleeve handle 92 is turned in the reverse direction, whereby the sleeve 90 is drawn downwardly within the bushing 98 and exerts pressure through the flange 94 upon the pivoted clamping member 87 to again clamp the tail stock in the adjusted position.

It will accordingly be evident that with various embodiments of driving mechanisms, my improved machine enables the ready profiling of cams or other irregular surfaces whereby duplicate cam shafts or other work may be supplied at the rate necessary for quantity production of internal combustion engines and the like.

Suitable lubrication for the several rotating parts and coolant for the cutters are supplied in the usual manner or in any desired manner. It will be noted that the bearing 76 for the center bearing on the cam shaft 20, is bridged over from the sides of the machine framework so as to permit the liquid lubricant or coolant to flow without interruption.

While it will be apparent that the illustrated embodiments of my invention herein disclosed are well calculated to adequately fulfill the objects and advantages primarily stated, it is to be understood that the invention is susceptible to variation, modification and change within the spirit and scope of the subjoined claims.

I claim:—

1. In a milling machine, the combination of aligned head stock and tail stock for receiving work to be milled, a pair of longitudinally slidable heads arranged in spaced relation with respect to said stocks, a plurality of milling cutters arranged and laterally movable in each of said heads, cam and lever means for independently moving each of said milling cutters laterally to and from the work, longitudinally sliding the heads and rotatably driving said cutters, all actuable from a single source of power.

2. In a milling machine, the combination of a rotary work holder, a pair of longitudinally slidable heads mounted at the sides of the work holder, a plurality of milling cutters mounted and laterally movable in each head, means for sliding said heads, means for rotating the milling cutters, and cam and lever means for laterally moving the milling cutters during the longitudinal sliding movements of said heads.

3. In a milling machine, the combination of a rotary work holder, a pair of slidable heads mounted at the sides of the work holder, a plurality of milling cutters mounted in each head and independently transversely movable with respect thereto, means for sliding said heads in opposite directions, a rotatable master shaft, a plurality of master cams removably mounted thereon, means for rotating the milling cutters while said heads are being slid, and means controlled by said master cams for independently moving the milling cutters transversely of said heads, including a plurality of levers fulcrumed intermediate their ends, and each having one of its extremities secured to one of the milling cutters, and its other extremity in constant contact with a master cam.

4. In a milling machine, the combination of a rotary work holder, a pair of slidable heads mounted at the sides of the work holder, a plurality of milling cutters mounted in each head movable transversely thereof, and each comprising a rotatable shaft, a slidable quill in which the shaft is rotatably mounted, and a collar adjustably mounted on the quill, a rotatable master cam shaft, a plurality of master cams removably mounted thereon, and means controlled by said master cams and connected with said collars for independently sliding the milling cutters transversely of the heads.

5. In a milling machine, the combination of a rotary work holder, a pair of slidable heads mounted at the sides of the work holder, a plurality of milling cutters mounted in each head movable transversely thereof, and each comprising a rotatable shaft, a slidable quill in which the shaft is rotatably mounted, and a collar adjustably mounted on the quill, a rotatable master cam shaft, a plurality of master cams removably mounted thereon, and means controlled by said master cams and connected with said collars for independently sliding the milling cutters transversely of the heads, comprising a plurality of levers having their extremities respectively engaging said master cams and collars.

6. In a milling machine, the combination of a rotary work holder, a pair of slidable heads mounted at the sides of the work holder, a plurality of milling cutters mounted in each head movable transversely thereof, and each comprising a rotable shaft, a slidable quill in which the shaft is rotatably mounted, and a collar adjustably mounted on the quill, a rotatable master cam shaft, a plurality of master cams removably mounted thereon, means controlled by said master cams and connected with said collars for independently sliding the milling cutters transversely of the heads, and means for driving the

several rotatable elements from a single source of power.

7. In a milling machine, the combination of a rotatable work holder, a pair of slidable heads at the sides of the work holder, a plurality of milling cutters rotatably and transversely slidably mounted in each head, a master cam shaft rotatably mounted below the work holder, a motor, means for driving the work holder, master cam shaft and the milling cutters from the motor, means comprising a drum cam actuated by the master cam shaft for sliding the said heads longitudinally of the work, and lever means also actuated thereby for sliding the milling cutters transversely of said heads.

8. In a milling machine, the combination of a rotatable work holder, a pair of slidable heads at the sides of the work holder, a plurality of milling cutters rotatably and transversely slidably mounted in each head, a master cam shaft rotatably mounted below the work holder, a motor, means for driving the work holder, master cam shaft and the milling cutters from the motor, means including a pair of cam drums rotated from the motor for sliding said heads, and means actuated from the master cam shaft for independently sliding the milling cutters transversely of said heads.

9. In a milling machine, the combination of a rotatable work holder, a pair of slidable heads at the sides of the work holder, a plurality of milling cutters rotatably and transversely slidably mounted in each head, a master cam shaft rotatably mounted below the work holder, a motor, means for driving the work holder, master cam shaft and the milling cutters from the motor, means including a pair of cam drums rotated from the motor for sliding said heads, and means actuated from the master cam shaft for independently sliding the milling cutters transversely of said heads, including a plurality of levers pivoted intermediate their ends and each having its upper extremity connected with a non-rotatable portion of a milling cutter, and its lower extremity in contact with a rotatable portion on the master cam shaft.

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