Feb. 20, 1940. D. J. CAMPBELL 2,190,931

CAMSHAFT TREATING MACHINE

Filed Jan. 9, 1939 6 Sheets-Sheet 1

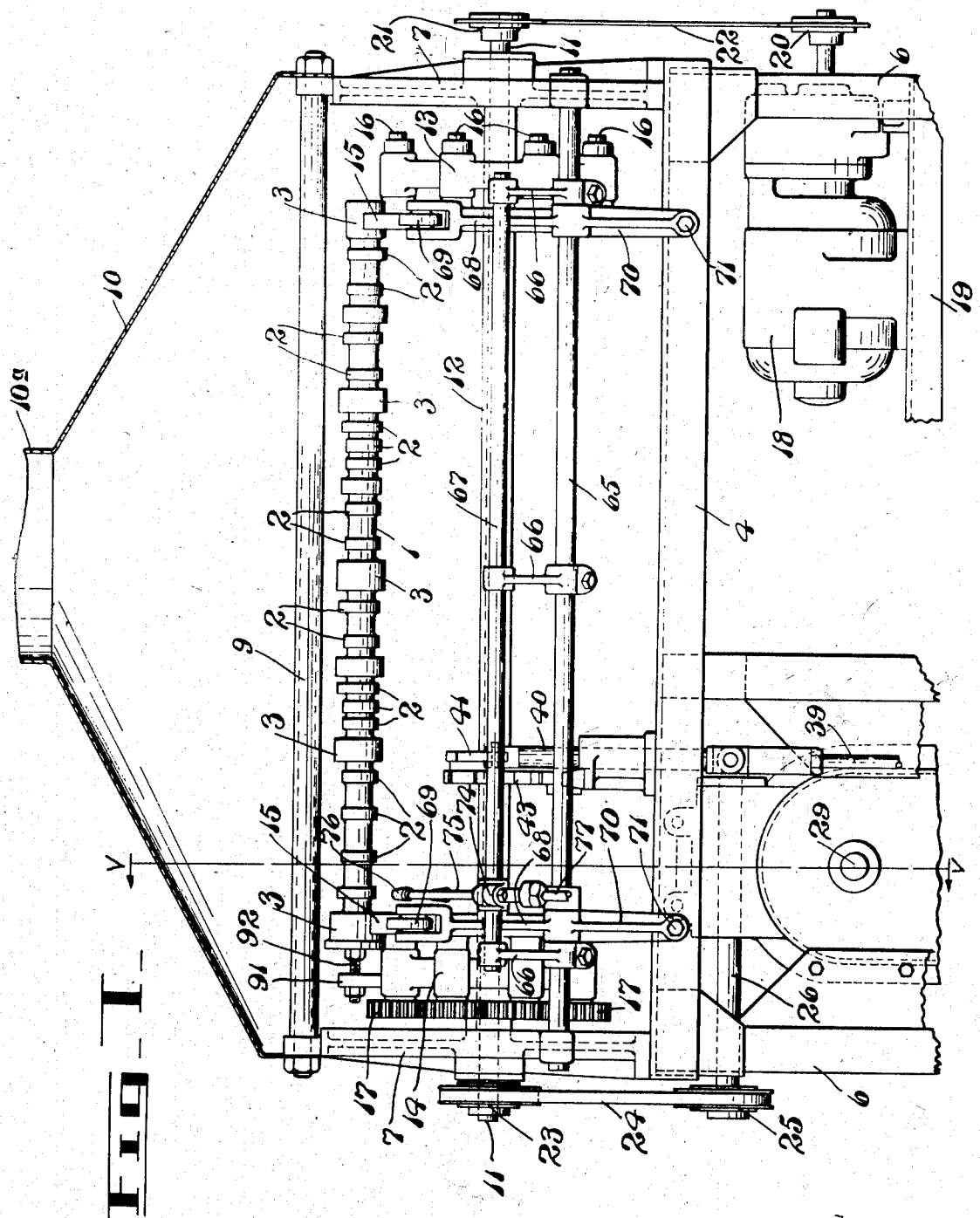


FIG. 1

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Fig. 2.

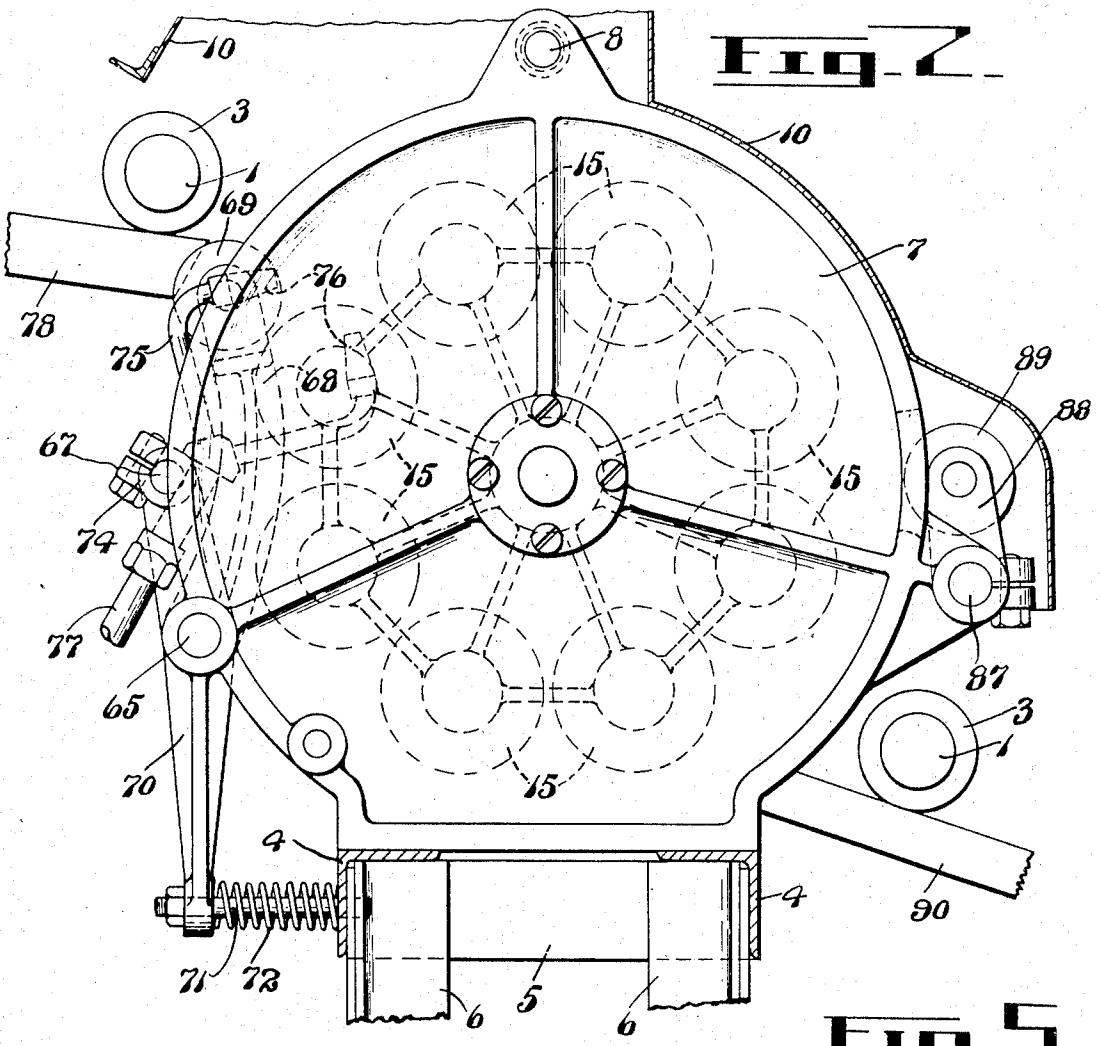
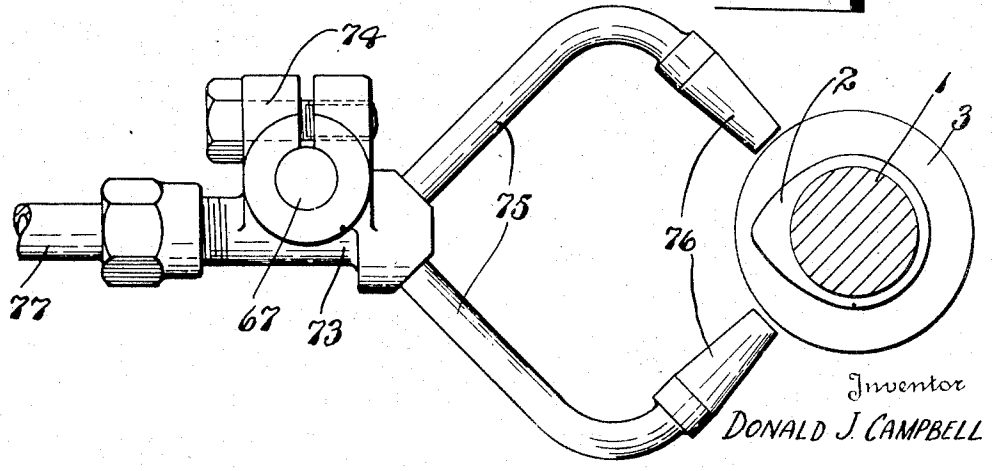


Fig. 5.



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Fig. 3.

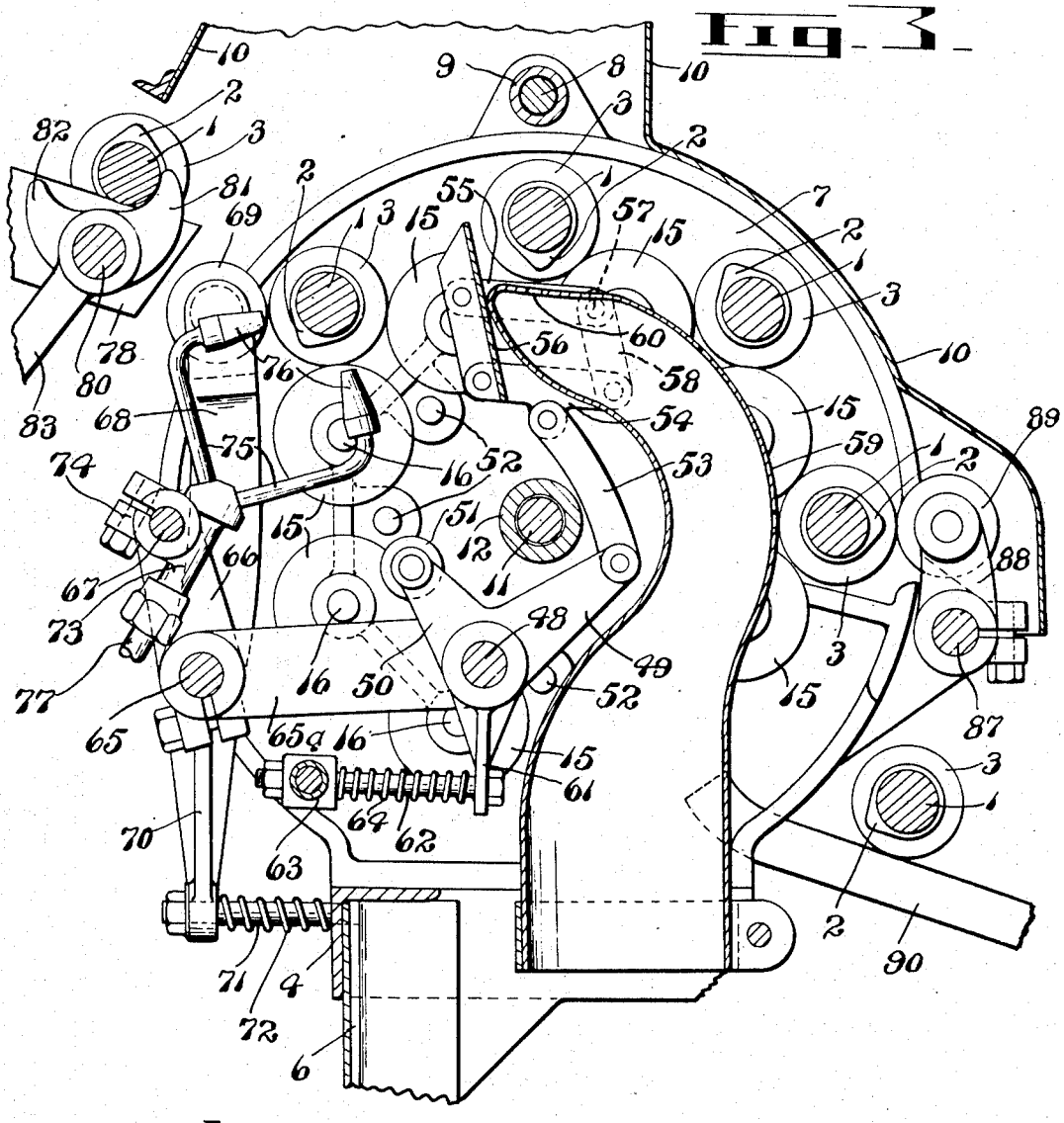
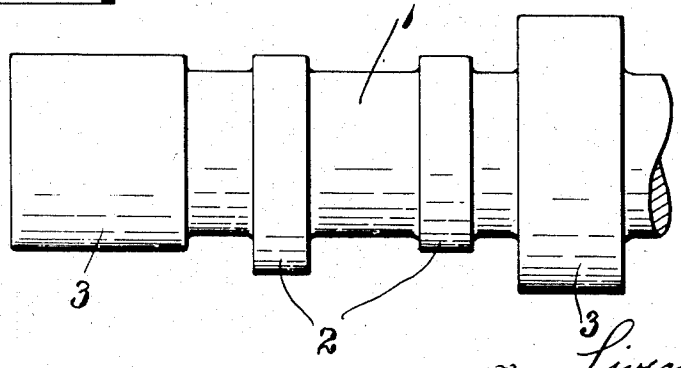


Fig 4.



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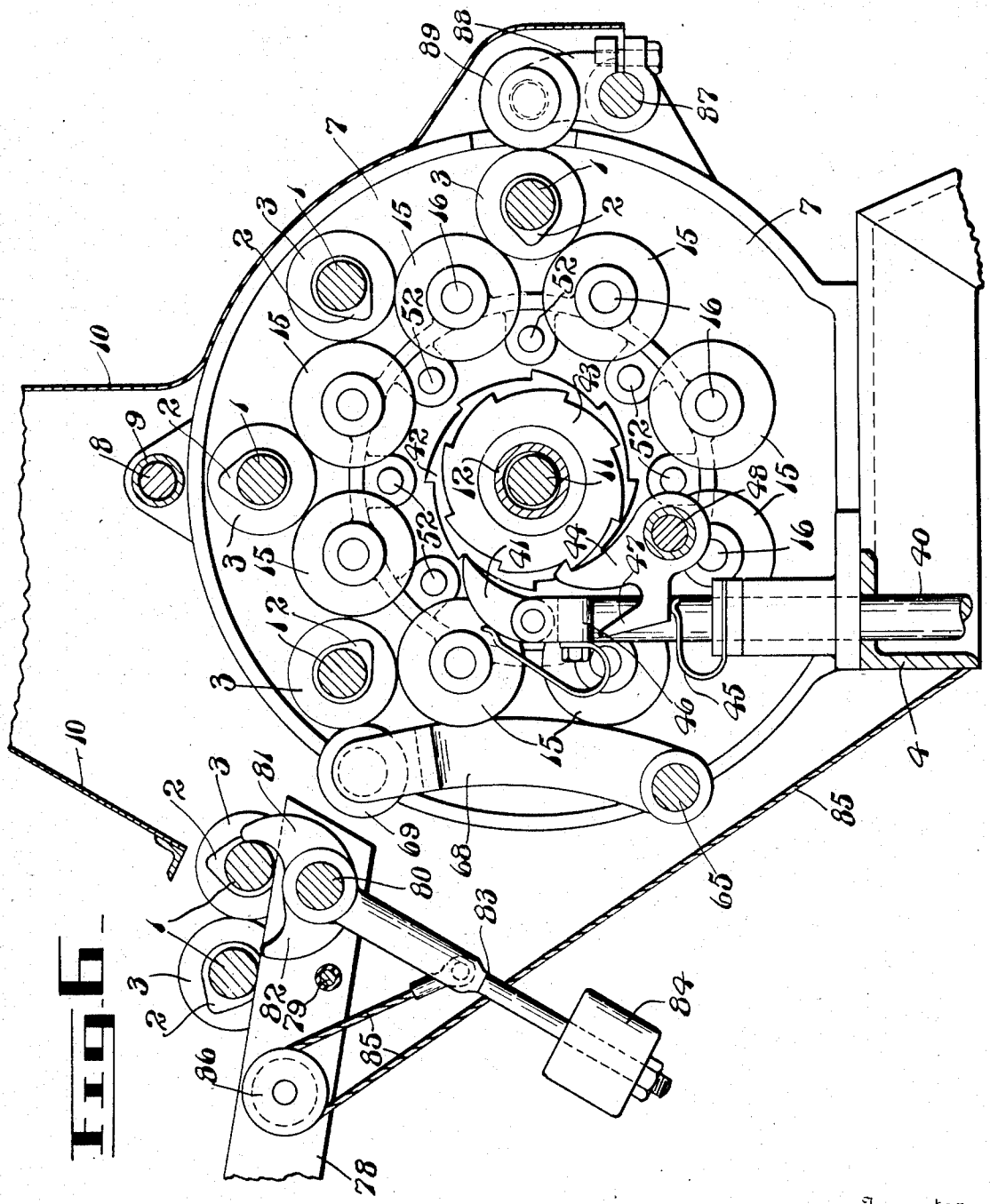


Fig. 6.

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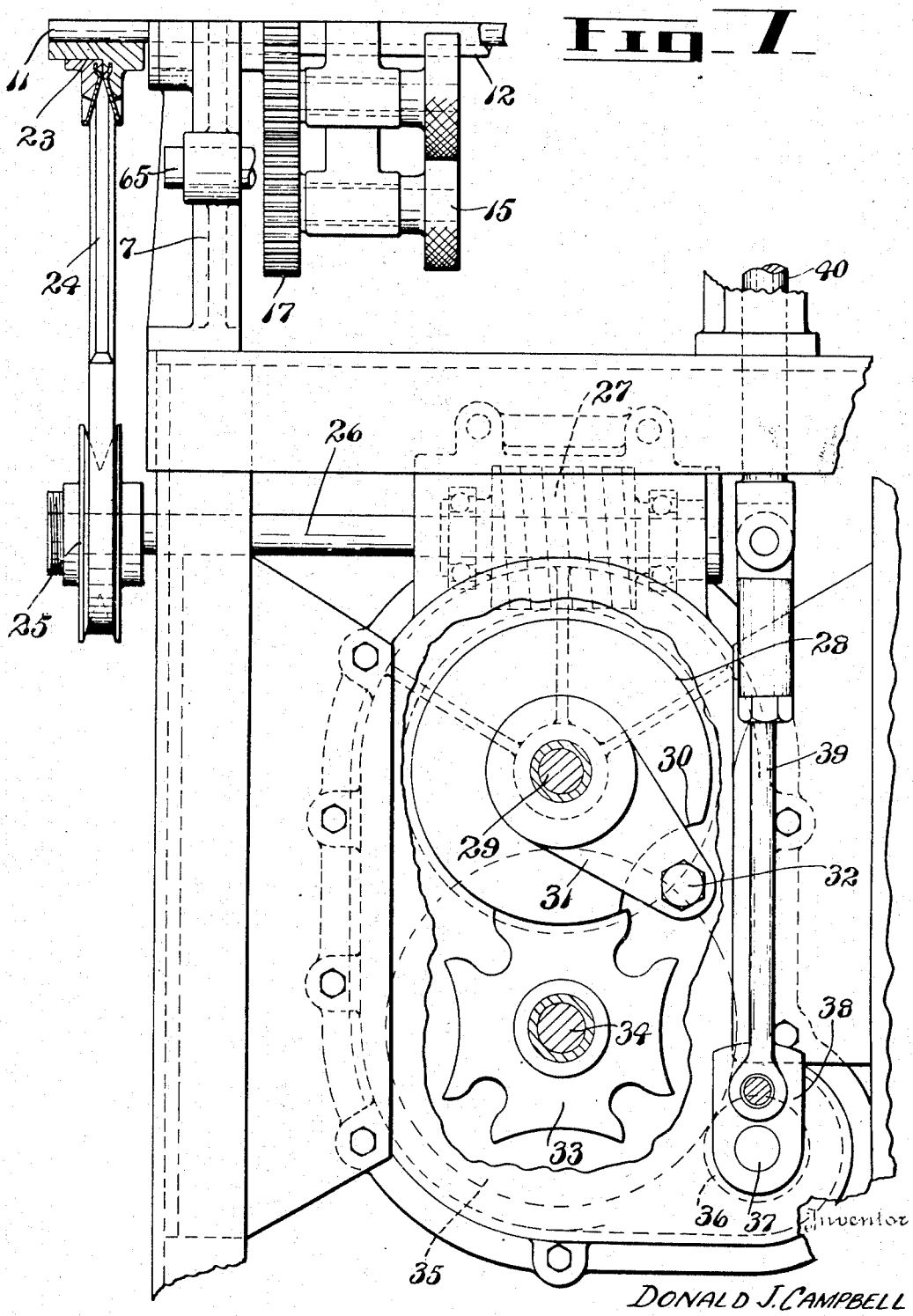
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Fig. 7



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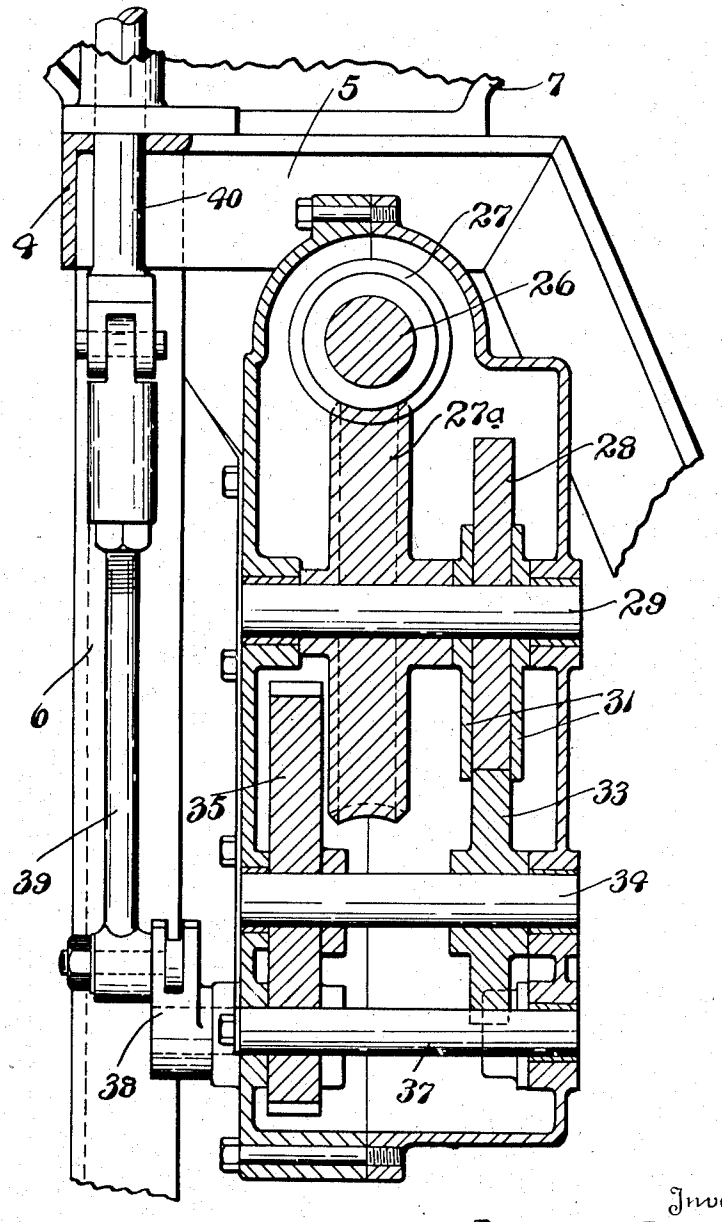
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Fig. 8.



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Patented Feb. 20, 1940

2,190,931

UNITED STATES PATENT OFFICE

2,190,931

CAMSHAFT TREATING MACHINE

Donald J. Campbell, Spring Lake Township, Ottawa County, Mich., assignor to Campbell, Wyant & Cannon Foundry Company, Muskegon Heights, Mich., a corporation of Michigan

Application January 9, 1939, Serial No. 249,911

4 Claims. (Cl. 266—4)

This invention relates to a machine for the treatment of cast camshafts, or like articles, wherein the cams in the length of a camshaft are first heated to a relatively high temperature and immediately cooled, the result being a hardening of the cams to enable them to sustain the wear to which they are subjected in use. The present invention has been used in the tempering and hardening of the cams of cast camshafts for internal combustion engines, such as are used in large amounts in motor vehicles. A camshaft in its length is equipped with cams for the control of both the intake and exhaust valves which are used to close the intake and exhaust ports to the cylinders of an engine, and which are lifted by the cams against the force of heavy springs and are returned to closing position by said springs, the cams operating against intervening tappets between them and the stems of the valves with resultant wear upon the cam surfaces which must be of a wear resisting character, which the cast cams as they come from the foundry operation and after they have been machined to size do not have so as to be able to withstand such service without hardening.

With my invention it is a primary object and purpose to produce a machine in which cams may be fed to the machine one after the other at suitable regulated intervals, the cams heated for a predetermined time to elevate the temperature to the desired degree, and immediately thereafter the heated cams on a camshaft are subjected to an application of mixed air and water vapor; and during the time that the cams of one shaft are being thus cooled by the projection of air and water vapor thereagainst, the following camshaft is having its cams heated. The camshafts are moved through the machine in a step-by-step rotative movement, a camshaft at one of the intervals between consecutive steps of movement being heated and at the succeeding interval being cooled by the application of the cool air and water vapor. It is thereafter carried to an outlet in the machine through which it passes and is carried away. With my invention a high quantity production in the tempering and hardening treatment of the cams is obtained with resultant economy of manufacture. The cams are cast from an alloy of cast iron in accordance with any desired means of casting. First heating cams and then treating the same by directing a mixture of air and water vapor at a desired relatively low temperature has been found to be particularly effective to get a hardened wearing surface of considerable depth without checks or cracking.

The invention consists in novel constructions and arrangements of parts and operations of the same for effectively attaining the hardening of the cams of camshafts as a substantially continuous process, with the result of greatly increased and more economical production.

The invention may be understood from the following description, taken in connection with the accompanying drawings, in which:

Fig. 1 is a front elevation of a machine according to my invention, with some parts shown in section and other parts removed for a better disclosure of the structure.

Fig. 2 is an end elevation with some parts shown in section.

Fig. 3 is a vertical section from front to rear substantially on the plane of the line V—V of Fig. 1, looking in the direction indicated by the arrows.

Fig. 4 is a fragmentary enlarged view of one end of a camshaft of the type to be treated in the machine.

Fig. 5 is a fragmentary enlarged side elevation of a heating unit, one for each cam at the length of a camshaft, the camshaft in Fig. 5 being shown in transverse section.

Fig. 6 is a vertical section similar to Fig. 1, the plane of the section being farther to the right than that of Fig. 3.

Fig. 6*a* is a vertical section and elevation similar to that shown in Fig. 6, illustrating a modification in structure.

Fig. 7 is an elevation with parts broken away and shown in section, illustrative of the Geneva mechanical movement by means of which the rotating cam carrying carriage is periodically moved in a step-by-step rotative movement, and

Fig. 8 is a vertical section therethrough, the section being in a plane at right angles to the elevation shown in Fig. 7.

Like reference characters refer to like parts in the different figures of the drawings.

The camshaft which is to be treated is an elongated casting having a cylindrical body 1 from which at spaced apart intervals cams 2, substantially of the shape shown in Fig. 5, project radially and at different radial directions from the cylinder body; and there are interposed at the ends and in the length of the shaft between groups of cams, cylindrical bearing sections 3 for mounting in spaced apart bearings on the engine block. The machine includes a stationary frame structure including a horizontal frame having front and rear rails 4, and end connecting rails 5 to provide a stationary frame which is

supported by vertical posts 6, all preferably of angle iron form in cross section. The supporting horizontal frame comprised of the rails 4 and 5 adjacent opposite ends has castings 7 connected to and extending upwardly therefrom of a general circular outline except at the bottom where resting upon and connected to the supporting frame, such end castings 7 at their upper ends have projecting lugs through which a rod 8 extends with nuts threaded onto the ends of the rod and with an elongated tubular sleeve 9 between said lugs, thereby providing a rigid structure. The upper portion of the machine is covered with a sheet metal hood 10 having an outlet 10a (Fig. 1) for drawing off products of combustion and the air and water vapor which are produced in the operation of the machine.

A shaft 11 extends between and through suitable bearings in the end supports 7, and is covered by a surrounding sleeve 12 loose thereon. The sleeve 12 adjacent its opposite ends carries heads 13 and 14, one for example at the right hand end of the machine, as in Fig. 1, and the other at the left. The heads are of substantially the same structure, generally of a circular form having radially extending bosses, eight in number as in the disclosure made, on each of which bosses a disk 15 is mounted for rotation by means of a short stub shaft 16 which passes through each of the equally spaced bosses and is rotatably mounted thereon. The disks 15 extend toward each other, the stub shafts 16 being horizontal and parallel to the axis of the shaft 11. At one end of the machine, the left hand end in Fig. 1, the shafts 16 are equipped with pinions 17 which are in meshing engagement with a gear carried on the shaft 11, whereby when shaft 11 is driven all of the disks 15 carried by the head 14 are rotated.

An electric motor 18 is mounted on a suitable supporting platform 19 (Fig. 1) below the horizontal frame 4, 5, its shaft having a drive pulley 20 thereon in the same vertical plane with a driven pulley 21 at one end of the shaft 11. An endless belt 22 around the pulleys 20 and 21 causes shaft 11 to be continuously driven by the motor 18 when it is operated. With this construction with the motor 18 running, shaft 11 will continuously rotate, the sleeve 12 on which the heads 13 and 14 are secured will remain stationary, and the disks 15 carried by the head 14 at one end of the machine will be continuously rotated. When a camshaft is located lengthwise of and between the two heads 13 and 14 and has its end cylindrical bearing enlargements 3 lying between and bearing upon two adjacent disks 15, the camshaft will be rotated through the rotating contact of the disks 15 carried by the head 14 and the other disks 15 carried by the head 13 will be rotated by the camshaft.

At the opposite end of shaft 11 a drive pulley 23 is secured having an endless belt 24 thereabout which also passes around a driven pulley 25 secured at the outer end of a short horizontal shaft 26 mounted immediately below the frame 4, 5. Shaft 26 carries a worm 27 (Figs. 7 and 8) which drives a worm wheel 27a secured upon a countershaft 29. A disk 28 is mounted on the countershaft 29 at one side of which is an arc-shaped recess 30. Arms 31, one at each side of the disk 28, are secured to and rotate with the countershaft 29, at their outer ends extending beyond the periphery of the disk 28 and having a bolt or pin 32 between the free ends of said arms. A star wheel 33 is connected with a second countershaft 34, being recessed or notched at four equally spaced apart points with concave arcuate peripheral sections between the notches or recesses, the radius of curvature of which is the same as the radius of curvature of the disk 28. This provides the well-known Geneva mechanical movement, it being evident that with each rotation of the shaft 29 a notch or recess in the star wheel 37 receives the pin 32 and the star wheel is turned one-quarter of a revolution and thereupon turns the shaft 34 through an arc of 90°.

The shaft 34 adjacent its front end is equipped with a relatively large gear 35 in meshing engagement with a pinion 36 (Fig. 7) fixed on a third countershaft 37. The rotation of the shaft 34 through one-quarter of a revolution causes a complete rotation of the pinion 36 and of the shaft 37. It is to be understood that the shafts 29, 34, 37 and the gearing mounted thereon are suitably mounted upon and carried within an enclosing housing as shown in Fig. 8.

At the front end of the shaft 37 and in front of said housing a crank arm 38 is fixed to said shaft. At a distance outward on the arm 38 a vertical pitman 39 is pivotally secured at its lower end and at its upper end has a pivotal connection to the lower end of a rod 40 mounted for vertical reciprocation. The rod 40 extends upwardly above the supporting frame 4, 5 and is guided in a suitable guide sleeve thereon, as shown in Fig. 6, and at its upper end carries a dog 41 pivotally mounted at one end thereon and spring impelled inwardly normally so that the free end of the dog engages a ratchet wheel 42 mounted upon the sleeve 12. A second ratchet wheel 43 adjacent the ratchet wheel 42 is also fixed to the sleeve 12 and is adapted to be engaged by a second dog 44, spring actuated by spring 45. The rod 46 has a yoke at its upper end, between the arms of which dog 41 is located and mounted, and the dog 44 has a tail piece 47 which extends underneath a shoulder provided at one side of the yoke whereby on downward movement of the rod 40 from the position shown in Fig. 6, the tail piece 47 is engaged and dog 44 moved counterclockwise to disengage from the ratchet wheel 43, thus permitting the dog 41 to move downward to connect with the next lower notch of the ratchet wheel 42. On the upward movement of the rod 40, dog 41 having engaged against the next lowermost ratchet tooth, disk 42 is rotated one step and disk 43 is engaged by the retaining dog 44, at the end of said movement stopping the sleeve 12 and the connected parts from rotating beyond an exact predetermined position, which it might tend to do under the momentum imparted by the thrust of the dog 40. It is evident that shaft 29 is rotated at a relatively low speed from the more rapidly rotating shaft 11, the reduction in speed being accomplished by the worm gearing 27 and 27a. Therefore, the sleeve 12, heads 13 and 14 and the disks 15 carrying the camshafts to be treated will remain in a relatively stationary position and will have no movement except the rotative movement imparted to the disks and through them to the camshafts. But, periodically, there will be a partial rotative movement of the cam carriage which is provided by sleeve 12, heads 13, 14 and the like amounting to one-eighth of a complete rotation at each step. The ratchet dogs 42 and 43 carry eight equally spaced apart teeth, there are eight disks 15 on the heads 13 and 14 in the disclosure made, and the periodic step-by-step

rotation of the camshaft carriage at predetermined intervals of time is through one-eighth of a complete rotation of said carriage.

The dog 44 is loosely mounted upon a horizontal rock shaft 48 which extends lengthwise of and is suitably mounted and carried by the supporting frame. A bell crank lever having diverging upwardly extending arms 49 and 50 is mounted on said shaft 48. The arm 50 at its free end is equipped with a roller 51. A plurality of pins 52, eight in number, extend from the head 14 inwardly, and as said head is moved one-eighth of a revolution by the step-by-step movement described, a pin engages the roller 51 and rocks the bell crank lever in a clockwise direction. A link 53 is pivotally connected at its lower end to the free end of arm 49 and at its upper end substantially at the middle of one bar 54 of a parallel bar arrangement, the second upper parallel bar being shown at 55. Both bars 54 and 55 at their forward ends are pivotally connected to a sheet metal shield 56. The upper bar 55 at its rear end is pivotally supported on a pivot 57 and a link 58 paralleling the shield 56 connects the rear ends of the said bars 54 and 55. On the clockwise movement of the bell crank lever the shield 56 is drawn downwardly and toward a horizontal position and is thus moved out of the way, whereby a camshaft, for example the one shown at the left in Fig. 3, may be moved to the next position on the one-eighth revolution of the camshaft carriage to a location in the rear of the normal position of the shield 56, moving to such position while the shield is lowered. A nozzle 59 through which air carrying water vapor may be forced under pressure and of the shape shown in Fig. 3, has its upper portion immediately back of the shield 56 and is provided with a series of outlet openings 60 at its upper side immediately below the camshaft, which after it has been heated in its first position in the machine, is carried to the second position directly over the openings 60, and has projected against its heated portions the mixed air and vapor through said openings 60.

The return of the shield 56 to its normal upper position, shown in Fig. 3, is accomplished by a spring. An arm 61 extends downwardly from the knuckle of the bell crank lever and through the lower end of the arm a headed rod 62 passes, pivotally and slidably mounted at its outer or forward end on a swivel block 63. A coiled compression spring 64 between the block and the arm 61 is compressed on the clockwise movement of the bell crank lever and when freed for return after a pin 52 has engaged with and passed from the roller 51, spring 64 expands and returns the parts to their normal position, as in Fig. 3.

A rock shaft 65 extends between and is mounted for rocking movement at its ends on the frame members 7. End and intermediate arms 66 secured at their lower ends to the rock shaft 65 extend upwardly and at their upper ends carry a horizontal rod 67 parallel to and in front of the shaft 11. On the rock shaft 65 toward each end thereof but within the heads 13 and 14 a lever is secured having an upwardly extending arm 68, upon which a roller 69 is mounted at its upper end, and a downwardly extending arm 70 through the lower end portion of which a headed rod 71 passes, being mounted at its inner end on the frame of the machine. Between the front frame bar 4 of the machine and the lower ends of the arms 70 and around the rods 71, coiled compression springs 72 are mounted which tend to turn the shaft 65 and the connected parts in a clockwise direction. An arm 65a secured at its forward end to the rock shaft 65, extends inwardly and at its inner end is in the path of movement of the pins 52 so as to be lifted at its inner end as a pin engages and passes thereby, rocking shaft 65 counterclockwise against the spring 72 which returns the parts to their original position after the pin which has engaged the operating arm 65a has passed by the end of the arm.

Along the length of the rod 67 a plurality of heating units are secured, one for each of the cams in the length of the camshaft to be heated. Each of said heating units (Figs. 3 and 5) includes a body 73 with a clamp 74 for clamping the same on the rod 67. The body 73 has a passage for fuel which at its upper end communicates with passages through diverging pipes 75 which, near their free ends, are turned inwardly toward each other and terminate in nozzles 76 positioned so as to direct flame against the cams 2 on the camshaft 1 when the parts are in their normal position, shown in Fig. 4. Fuel is carried through flexible conduits 77. It will be noted that on the counterclockwise rotation of the rock shaft 65, the rollers 69 are moved outwardly and the heating units are likewise carried outwardly. The rollers 69 during the times when the camshaft carriage is at rest and while the camshaft which has just been introduced into the machine is being heated, bear against parts 3 of such camshaft, as shown in Fig. 3. But when the camshaft carriage is to be turned the one step of one-eighth of a revolution, rollers 69 are moved away from the camshaft with which engaged, permitting it to be moved onto the next position in the machine and permitting the carriage to take a position where it may receive a camshaft from the outside to be carried between the next consecutive pairs of disks 15.

The camshafts which are to be treated are located one back of the other on an inclined feed table which may comprise a plurality of bars 78 extending forwardly and upwardly away from the front of the machine, the front end of said bars terminating a short distance within the lower edge of the hood 10 (Figs. 3 and 6). The bars together with cross rods 79, Fig. 6, provide a rigid frame down which the camshafts to be treated roll by gravity. A rock shaft 80 extends through the delivery end portions of the inclined bars 78 and in its length carries curved fingers 81 and 82 which extend opposite each other but at their ends are both curved upwardly. An arm 83 is secured to the shaft 80 extending downwardly and forwardly, and at its lower end carries a weight 84, the normal tendency of which is to rock shaft 80 counterclockwise and lift the fingers 81 into a position to interpose in the path of movement of the camshafts and hold the lowermost camshaft from entering the machine until shaft 80 is rocked in an opposite direction. When rocked in the opposite direction the fingers 81 are lowered below the upper edges of the bars 78 while the fingers 82 are lifted and hold the next to the lowermost camshaft from following the lowermost camshaft into the machine. Then when the shaft 80 returns to its original position the next succeeding camshaft rolls by gravity downward until stopped by the then outwardly extending fingers 81. A cable 85 is connected to the arm 83 between the ends of said arm, runs upwardly and forwardly over an idle pulley 86 and thence downwardly to the rod 40 with which it is connected, whereby on the

downward movement of the rod 40, shaft 80 is rocked in a clockwise direction to release the lowermost camshaft on the inclined feed bar 78 for entrance to the machine.

At the rear of the machine and at the outlet end of the hood 10 a horizontal rod 87 is longitudinally mounted, carried by the end frame members 7, from which arms 88 extend upwardly. Rollers 89 are mounted at the upper ends of the arms 88, which arms may be impelled forwardly by springs. Thus the rearmost camshaft retained in the machine will be held in position and not drop out of the machine until the camshaft carriage has been rotated an additional step to carry said camshaft past the rollers 89 whereupon the shaft is dropped upon a downwardly and rearwardly inclined table 90 down which it rolls away from the machine.

The head 14, as shown in Fig. 1, has a plurality of outwardly extending lugs 91 between consecutive bosses which carry the disks 15, on each of which a locating and adjusting screw 92 is mounted, against the end of which one end of the camshafts entering the machine are adapted to be positioned to properly locate the various cams 2 with reference to the heating nozzles 76. When a camshaft enters the machine in accordance with the hereinbefore described operation, it is engaged by consecutive disks 15 at each end of the camshaft carriage and after entrance is pressed against adjacent its ends by the rollers 69. The disks 15 rotating continuously, the camshafts are continuously rotated. The flame from the nozzles 76 is directed against the cams and all portions around the shaft in the same planes with the cams. Such heating continues for a period of time or until the shaft 29 makes a complete revolution. Thereupon all of the several series of operations described take place in proper order. The rod 40 is reciprocated, the camshaft carriage is rotated one step, the shield 56 is withdrawn, the rollers 69 are moved outwardly, the heating units are moved downwardly and outwardly and the shaft 80 is rocked to lower the retaining fingers 81 whereupon the camshaft which has been heated is moved to the second stage or directly over the opening 60 in the air and water vapor ejecting housing 59, and a new camshaft enters the machine for heating. The cold camshaft which has come into the machine is thereupon heated while the shaft with the heated cams is rapidly cooled and the temperature very rapidly lowered with a resulting hardening of the cams. The shield at 56 prevents the cooling medium from interfering with the proper heating of the cams of the shaft which is being heated, and also interposes in the path of heated products of combustion going to the heated cams which are being cooled. The shafts which have been thus treated are retained in the machine until three succeeding steps of operation have been performed and are thereupon delivered to the table 90.

The mechanism is timed in conjunction with the heating elements, so that a camshaft which is being simultaneously turned about its longitudinal axis and the cams thereon heated, is held in a position to be heated sufficiently long that the cams will receive a temperature producing a red heat which may approximate 1100, 1200 or 1300° F. The temperature of the cooling fluid which, preferably, comprises air carrying water vapor will be approximately 80° F. These temperatures both for the heating of the cams and of the cooling fluid may be subject to some variation. The quantity of water vapor carried by the air may also be varied if desired for obtaining different hardening effects. The cams of a shaft which have been heated are subjected to the projection of the cooling fluid thereagainst for the same length of time that the next succeeding shaft is being heated, whereby the heated cams become completely cooled.

With the machine as described, rapid hardening treatment of the cams of camshafts is accomplished with a resultant high quantity production. It is of course to be understood that many changes and variations in constructive detail may be resorted to without departing from the invention. And while the camshaft carriage in the disclosure made rotates one-eighth of a complete rotation at each step of movement and, therefore, the ratchet wheels are equipped with eight teeth and the machine is otherwise designed to correspond, the invention is the same should the step-by-step movement be of a lesser or greater degree, the number of steps of movement required to make a complete revolution not being necessarily or essentially restricted to eight. Various other changes in design or detail of construction may be resorted to without departing from the invention which is defined in the appended claims. All forms of structure coming within the scope of the claims are to be considered as comprehended by my invention.

I claim:

1. In a machine of the class described, a movably mounted camshaft carriage adapted to carry a number of camshafts spaced apart from each other on said carriage, means for periodically moving said carriage in step-by-step movements with rest intervals between steps of movement, means for delivering a single camshaft to the carriage at each step of movement thereof, means for heating the cams on a shaft immediately after its delivery to the carriage and during a rest interval of said carriage, means for simultaneously projecting a cooling fluid against the heated cams of the immediately previously heated camshaft, and movable means extending between the camshafts which are being simultaneously heated and cooled to guard the one from the heating means and the other from the cooling means, combined with means for automatically withdrawing said guarding means during the periods of movement of the carriage.

2. In a machine of the class described, a movable camshaft receiving carriage, means for moving said carriage in step-by-step movements with intervals of rest between steps of movement, an inclined way having its lower end adjacent the carriage, a plurality of camshafts being adapted to be placed on said way one behind the other to move by gravity to said carriage, a rock shaft at the lower end of the way, fingers on said shaft normally extending into the path of movement of said camshafts on the way to hold them from leaving said way, means in operative timed relation with the carriage moving means for rocking said rock shaft to move said fingers out of normal position and free the lowermost camshaft whereby it may leave the way and be delivered to said carriage, other fingers on said rock shaft moved by said rocking movement into the path of movement of the next succeeding camshaft on the way, means for heating a camshaft after delivery to the carriage and during an interval of rest thereof, and means for cooling the heated cams on said camshaft at a succeeding rest position of the carriage and camshaft after heating.

3. In a machine of the class described, a movable camshaft receiving carriage, means for moving said carriage in step-by-step movements with intervals of rest between steps of movements, means for delivering a camshaft to the carriage at each step of movement thereof, means for heating cams on a camshaft after delivery to said carriage and during an interval of rest, means for cooling heated cams on said camshaft at a succeeding rest position of the carriage and camshaft, a shield normally extending between a shaft which is being heated and a shaft which is being cooled, and means in operative timed relation with the carriage moving means for automatically withdrawing said shield during step-by step movements of the carriage.

4. The combination of elements defined in claim 2 combined with a shield normally extending between a shaft which is being heated and a shaft which is being cooled, and means for automatically withdrawing said shield during step by step movements of the carriage.

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