May 24, 1955 H. E. BALSIGER 2,708,816

TAPERED CAM GRINDER

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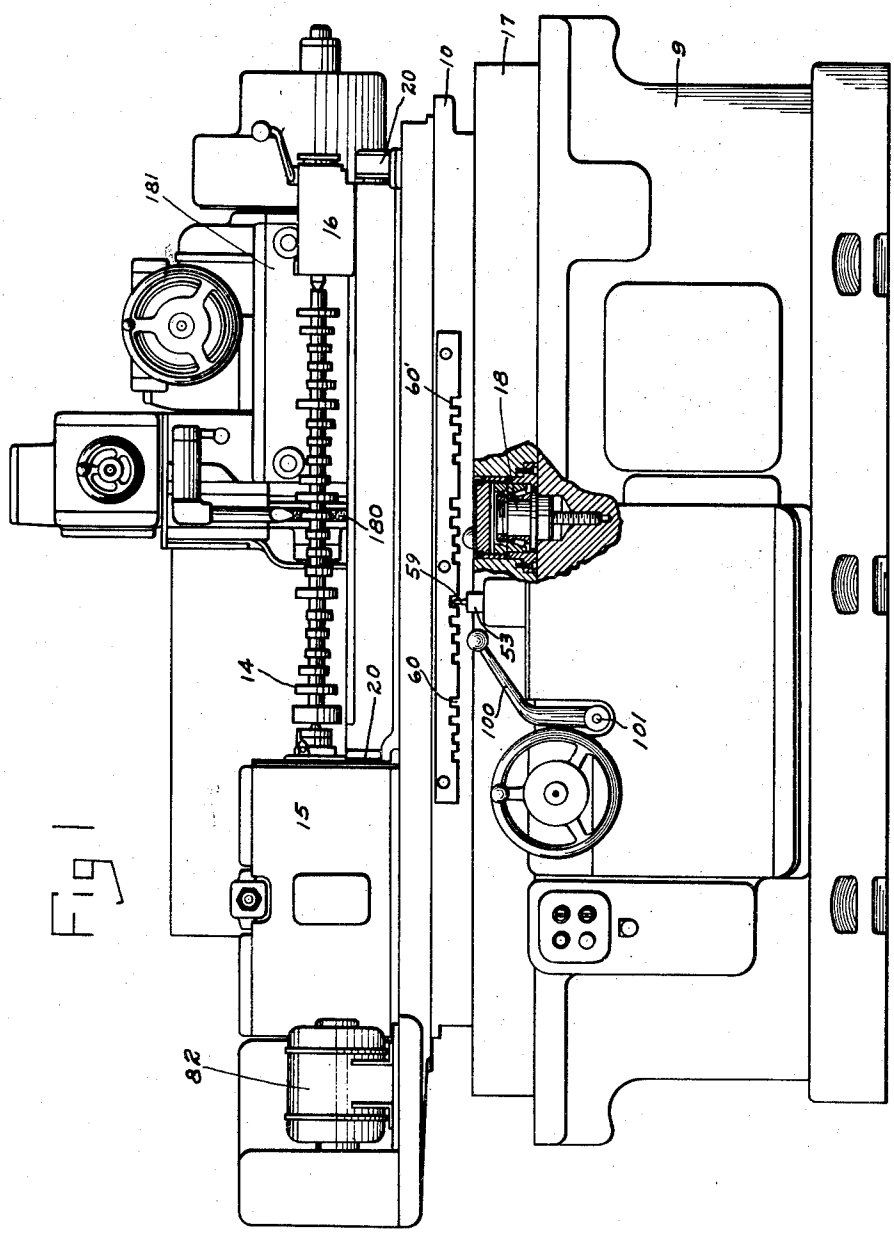


Fig. 1

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Fig 4

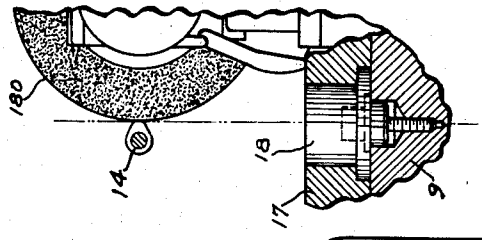


Fig 2

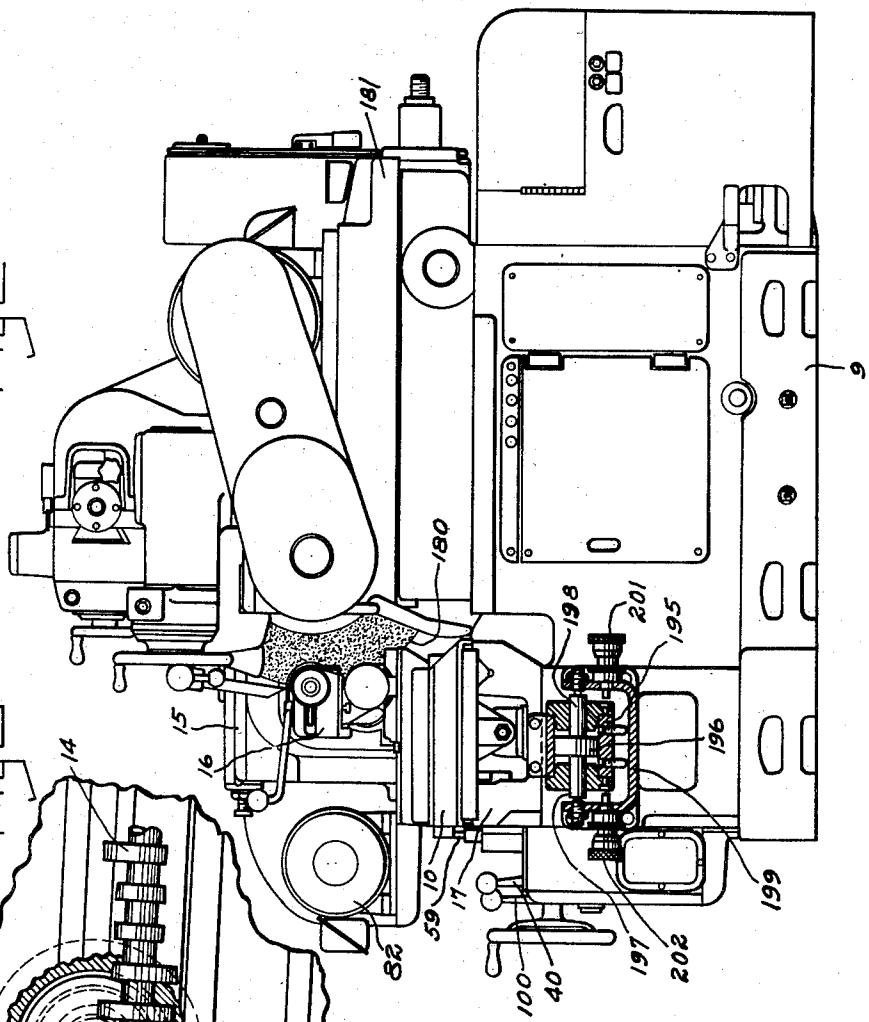
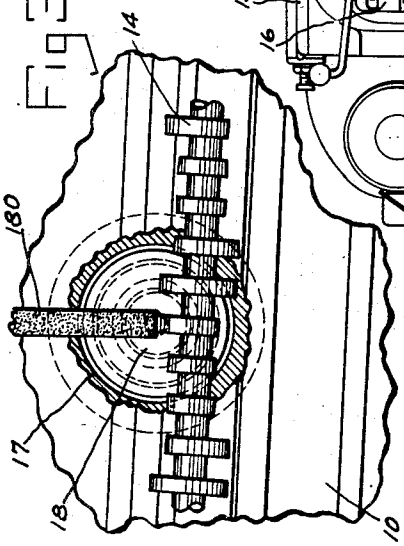


Fig 3



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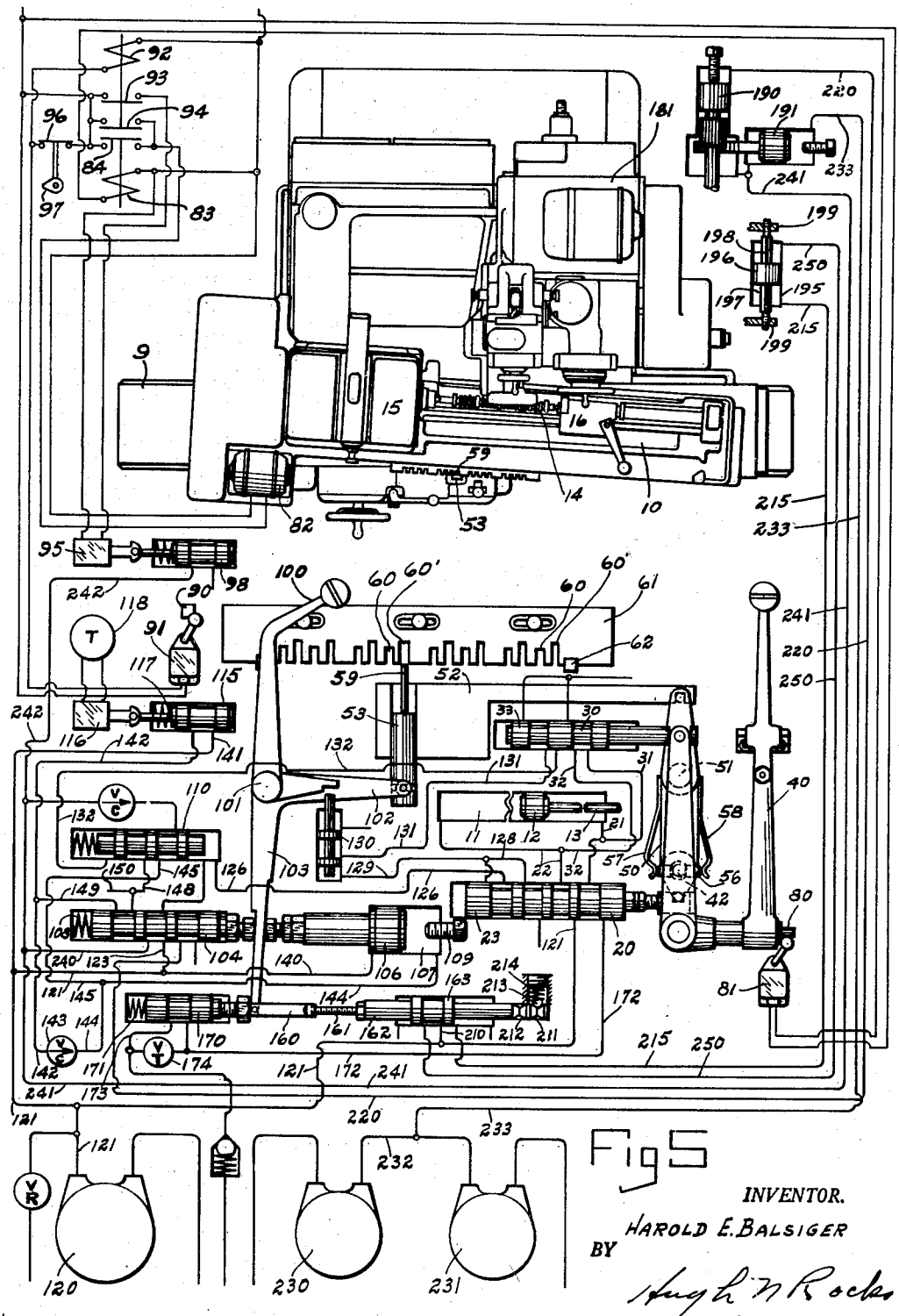


Fig 5

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2,708,816

TAPERED CAM GRINDER

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Application November 2, 1951, Serial No. 254,499

9 Claims. (Cl. 51—105)

This invention relates to machines for grinding cam shafts, particularly where some of the cams are tapered in one direction and others in the opposite direction.

The present method for grinding cam shafts of this type consists of a pivotally mounted wheel support which is shifted alternately between two angular positions corresponding to the direction of the taper to be ground on the cams of the cam shaft. The principal disadvantage of this method of providing an angular relation between the surface of the cam to be ground and the grinding wheel lies in the fact that when the wheel base is swivelled the surface of the grinding wheel occupies a different longitudinal position relative to the work piece in each angular position to which it is adjusted. This disadvantage may be overcome if the pivot point is placed in such position that it is slightly in advance of the peripheral surface of the grinding wheel in the direction of the work axis. Since the front of the grinding wheel overhangs to some extent the work carriage, to place the pivot point of the wheel base in advance of the grinding wheel would mean that it would have to be somewhere directly under the work carriage. This would introduce undesirable complications in machine design.

It is therefore an object of this invention to provide a machine for grinding tapers on the cams of a cam shaft wherein the pivot point for providing the angular relation between work and grinding wheel may be located to best advantage both as to effect on the work to be ground as well as on the design of the machine.

A further object is to provide means for swivelling the work carriage about an axis in fixed longitudinal relation to the grinding wheel.

A further object is to provide a swivelling base member for the work carriage.

Fig. 1 is a front elevation partially cut away to show the work swivelling pivot.

Fig. 2 is an elevation with the swivelling motor in section.

Fig. 3 is a partial plan view showing relation between grinding wheel, work surface and swivel pivot.

Fig. 4 is a partial end view partly in section showing the same elements as Fig. 3.

Fig. 5 is a hydraulic and electric diagram.

The means for automatically indexing carriage **10** from cam to cam is described in detail in co-pending application Serial No. 209,160 filed February 2, 1951, now Patent 2,654,189 granted October 6, 1953.

The means for swivelling member **17** and work carriage **10** consists of a cylinder **195** attached to said slide member **17** and having a piston **196** slidably mounted therein. Piston rods **197** and **198** extend through the ends of said cylinder to engage bracket **199** on bed **9**. Adjusting screws **201** and **202** in bracket **199** determine the extent of movement of member **17** about swivel point **18**.

Operation

Assuming carriage **10** to be in the extreme left-hand position with portion **59** of plunger **53** against stop **62**,

lever **40** is moved to the right. Valve **20** is shifted to the right also, as is valve **30**. With lever **40** in this position, projecting member **80** thereon closes headstock limit switch **81**, energizes relay **83** which closes contact **84** to complete the circuit to headstock motor **82**. In the right-hand position, valve **20** directs fluid under pressure from line **121** through line **22** to the head end of cylinder **11**, causing piston **12** to move carriage **10** to the right until portion **59** of plunger **53** drops into the first notch **60'** in response to the action of spring **108** transmitted through valve **104**, arm **103**, shaft **101**, and arm **102**.

When portion **59** of plunger **53** drops into the first notch **60'**, lever **100**, moving in a counterclockwise direction in response to the action of said spring **108**, acts through yoke **160** to move along adjusting screw **161** until it engages stem **162** of valve **163** and moves said valve to the right so that ball **213**, pressed by spring **214**, slips out of groove **211**, which locates said valve in the left-hand position, and into groove **212**, which locates said valve in the right hand position. Counterclockwise movement of lever **100** releases valve **170**, which is moved to its right-hand position by spring **171**. In this position, fluid from the rod end of cylinder **11** is prevented from discharging through line **172** and through said valve to exhaust passage **173**. Line **172** is connected to exhaust **173** through throttle valve **174**. This cushions the stopping of the carriage after plunger **59** drops into one of the notches in spacing bar **61**.

In the right hand position of valve **163**, fluid under pressure from pump **120**, line **121**, and line **210**, is connected to line **215** leading to the front end of cylinder **195** and causing said cylinder to move forwardly (in Fig. 5) to shift member **17** and work carriage **10** in a clockwise direction to place said carriage in the position shown in Fig. 5 for grinding a tapered surface corresponding to the angular position of said carriage. When member **17** is thus swivelled, guide surfaces for said support which are on said member are also shifted so that in the new position the carriage **10** may be indexed in a direction parallel to the tapered surface to be ground on the work piece.

Carriage **10** continues to move after the plunger has entered the notch until the side of the notch engages said plunger, shifting the plunger to the right. This movement is transmitted through sliding member **52** to lever **50**, moving said lever in a clockwise direction and shifting valve **20** to the left until line **121** is blocked, thus preventing further flow of fluid under pressure to cylinder **11** and stopping the movement of carriage **10**.

As indicated above, the counterclockwise movement of lever **100** is effected by spring **108**, shifting valve **104** to the right in engagement with the extension **103** of lever **100**. In the right-hand position of valve **104**, fluid under pressure from line **121** enters said valve through line **123** and is directed by said valve through line **220** to the head end of the piston **190**, initiating the rapid positioning movement of wheel support **181**. At the same time, a differential pump type fluid supply, such as shown in Patent No. 2,509,368, granted May 30, 1950, serves to supply fluid under pressure at a measured rate to the head end of slow feed piston **191**. Said system consists of two pumps **230** and **231** which may be of different displacement or operated at different speeds so that pump **231** discharges a supply smaller in volume than pump **230**. The discharge end of pump **230** is connected through a line **232** to the intake end of pump **231**. Another line **233** connects line **232** with the head end of piston **191** and supplies a small volume of fluid thereto at all times, which is the difference between the output of pump **230** and that of pump **231**.

It should be noted here that lever **50** is moved in a

clockwise direction while lever **40** remains stationary in its right-hand position. This movement of lever **50** while pin **42** in lever **40** remains stationary causes spring **58** to be placed in tension against pin **56**.

When valve **30** moves to the right, the connection between lines **31** and **32** is blocked so that fluid under pressure will be conducted to the head end of piston **12**. At the same time the left-hand section **23** of reversing valve **20** directs fluid under pressure from line **126** through lines **128** and **129**, valve **130** and line **131** to the left-hand section **33** of valve **30**. With valve **30** in the right-hand position, fluid from line **131** is directed through line **132** to the left hand end of valve **110**, shifting said valve to the right to connect line **145** with line **148** leading to exhaust line **150**. Line **145** through valve **110** connects line **144** and the head end of cylinder **107** with said exhaust passage **150**.

The head end of cylinder **107** being thus connected with exhaust line **150**, the fluid under pressure always available in line **140** at the other end of said cylinder moves piston **106** to the right until stopped by adjusting screw **109**. This permits the above described action by which plunger **53** engages the first notch in the spacing bar.

After carriage **10** has been positioned for the grinding of the first cam, timer **118** may be started by any suitable means, such as movement of wheel base **181** to grinding position, to determine the duration of the grinding operation or any part thereof.

At the end of the predetermined period, said timer deenergizes solenoid **116**; and valve **115** is moved to the right by spring **117**. In this position of valve **115**, the fluid under pressure in line **141** is directed through line **142**, check valve **143**, and line **144** to the right-hand end of cylinder **107**, moving piston **106** to the left. This movement of piston **106** causes arm **103** and associated parts to be rotated in a clockwise direction to withdraw plunger **53** from the first notch **60** in spacing bar **61** and also to shift valve **104** to the left against spring **108**.

In the left-hand position of valve **104**, fluid under pressure from line **123** is directed through line **240**, line **241** to the rod end of both of the pistons **190** and **191** to cause withdrawal of wheel support **181** from grinding position and resetting of slow feed piston **191**. Fluid under pressure from line **240** also passes through line **242** to dresser valve **98**. However, no dressing operation occurs until all the cams on a shaft have been ground, at which time valve **98** is shifted by solenoid **95**.

The clockwise movement of lever **100** also serves to shift yoke **160** to the left. Near the end of its movement in this direction, said yoke picks up the head of adjusting screw **161** in valve stem **162** of valve **163** and shifts said valve to the left-hand position shown. In this position, fluid under pressure from line **210** is directed through line **250** to the rear end of cylinder **195**, moving said cylinder backwardly and shifting said support in a counterclockwise direction. In this position, grinding wheel **180** will grind the next cam on the shaft to a surface tapered in the opposite direction to that of the first cam.

Where two or more successive cams are tapered in the same direction followed by two or more tapered in the opposite direction, the swivelling of the work carriage may be controlled by using a spacing bar in which the deep and shallow notches are arranged to conform to the grouping or arrangement of cams according to the direction of taper. For example, in the arrangement mentioned above the spacing bar would have two or more successive deep notches followed by two or more shallow notches as shown in Fig. 1.

Because of the tension in spring **58**, lever **50** is rotated in a counterclockwise direction about its pivot **51** to shift valve **20** to the right and sliding member **52** and plunger **53** to the left out of alignment with the notch from which it has just been withdrawn. The previously

described indexing movement is repeated, carriage **10** moving again to the right until the plunger drops in the next notch. The next notch **60** is not as deep as the first notch **60'**, and as portion **59** of plunger **53** drops into notch **60**, lever **100** moves in a counterclockwise direction; but because of the fact that notch **60** is not as deep as notch **60'**, the movement of said lever is limited so that it does not move far enough to shift valve **163**, which remains in the left-hand position. The cycle of operations which constitute the grinding of a single cam is repeated for successive cams until the last one is ground.

After grinding the last cam on a shaft, lever **40** is moved manually to the left-hand position. This movement releases headstock limit switch **81**, shifts valve **30** to the left-hand position, and puts spring **57** in tension. Valve **20** remains in central position.

Opening switch **81** deenergizes relay **83** and opens the circuit to motor **82** through contact **84**.

As carriage **10** moves into position to grind the last cam, dog **90** on said carriage engages dresser limit switch **91**, energizing relay **92** and closing contacts **93** and **94**. Closing contact **94** completes a circuit parallel to that through contact **84** and maintains motor **92** in operation after the contact **84** has been opened. When carriage **10** returns to its left-hand position switch **91** is released and motor **82** stops.

Contact **93** completes a circuit to dresser solenoid **95** to initiate a wheel dressing operation similar to those described in the above mentioned patents. Said solenoid shifts a valve **98** to direct fluid under pressure to actuate a dressing mechanism, (not shown).

With valve **30** in the left-hand position, the connection between lines **31** and **32** is blocked. In this position the left-hand section **33** of valve **30** blocks line **131**, preventing flow of fluid under pressure to the left end of valve **110** and exhausts the left-hand end of valve **110** through line **132** and valve **30** so that said valve **110** moves to the left-hand position.

When timer **118** functions at the end of the grinding operation on the last cam, deenergizing valve **116**, valve **115** is returned to the right-hand position, directing fluid under pressure through line **142**, check valve **143**, line **144** to the head end of cylinder **107**, moving piston **106** to shift valve **104** to the left and withdraw plunger **53** from spacing bar **61**. The withdrawal of said plunger permits spring **57** to shift lever **50** in a clockwise direction, moving valve **20** to the left and directing fluid under pressure from line **121** through line **21** to the right-hand end of cylinder **11**. Piston **12** and carriage **10** move to the left, but plunger **53** is prevented from dropping into the notches **60** and **60'** during this movement because valve **110** has remained in the left-hand position, thus maintaining pressure fluid on the head end of cylinder **107**. The carriage, therefore, continues to move to the left under plunger **53** is engaged by stop **62**, shifting said plunger slightly to the left and through sliding member **52**, rotating lever **50** in a counterclockwise direction to return valve **20** to neutral position and thus shut off the supply of fluid to cylinder **11**.

When carriage **10** begins to move to the left, limit switch **91** is released, opening contacts **93** and **94**. Opening contact **94** breaks the circuit to motor **82**. However, contact **94** is by-passed through contact **96**, which is actuated by a cam **97** on the headstock spindle. This cam engages the contact only when the cradle has been dropped to inoperative position, as described in Patent 2,243,410 granted May 27, 1941.

While the apparatus described above is specifically for grinding successive cams having oppositely tapered surfaces, it is to be understood that it may be adapted to the grinding of cam shafts on which oppositely tapered cams are irregularly distributed without departing from the spirit of the invention.

I claim:

1. In a machine of the kind described, a bed, a work

support, a grinding wheel support, a grinding wheel rotatably mounted thereon, means for effecting longitudinal movement of one of said supports relative to the other, means to effect said movement intermittently to successively position said grinding wheel and spaced portions of the work piece in operative relation including a spacing bar having notches spaced in accordance with the spacing of said portions to be ground and a plunger for engaging the notches in said spacing bar, means for effecting a swivelling movement of said work support in order to grind tapered surfaces in different directions on some of said portions including a member mounted on said bed for angular adjustment about a longitudinally fixed vertical axis in the plane of said grinding wheel, said work support being slidably mounted on said angularly adjustable member so that each of said portions is presented to the grinding wheel in the same transverse and longitudinal position in relation to said axis, and means for initiating the swivelling of said angularly adjustable member in timed relation with the intermittent movement of said carriage to place each of said spaced portions in predetermined angular relation to said grinding wheel.

2. In a machine of the kind described, a bed, a work support, a grinding wheel support, a grinding wheel rotatably mounted thereon, means for effecting a longitudinal movement of one of said supports relative to the other, means to effect said movement intermittently to successively position said grinding wheel and spaced portions of a work piece in operative relation including a spacing bar having notches spaced in accordance with the spacing of said portions to be ground and a plunger for engaging the notches in said spacing bar, means for effecting a swivelling movement of said work support in order to grind tapered surfaces in different directions on some of said portions including a member mounted on said bed for angular adjustment about a longitudinally fixed vertical axis which is tangent to the face of the grinding wheel when said grinding wheel is in work engaging position, said work support being slidably mounted on said angularly adjustable member so that regardless of the longitudinal position of said carriage relative to the grinding wheel the portion to be ground will always be in the same position transversely thereof, means operable in response to movement of said plunger for swivelling said angularly adjustable member to place each of said spaced portions in predetermined angular relation to said grinding wheel.

3. In a machine of the kind described comprising a bed, a grinding wheel support slidably mounted thereon, a grinding wheel rotatably mounted on said support, a work support comprising a swivelling table mounted on said bed for adjustment about an axis passing through the point of contact between said grinding wheel and the surface of a work piece, a work carriage slidably mounted on said table, a headstock and footstock on said carriage for rotatably supporting a work piece thereon, means for effecting relative transverse and longitudinal movement between said carriage and said grinding wheel, means to effect said longitudinal movement intermittently to locate spaced portions of a work piece successively in operative relation to the grinding wheel and said swivel axis and means actuated by the means for effecting said intermittent movement for controlling the operation of said swivelling means to adjust said work support in opposite directions whereby the surfaces of said spaced portions are ground to a taper in opposite directions.

4. In a machine of the kind described, a bed, a grinding wheel support slidably mounted thereon, a grinding wheel rotatably mounted on said support, a work support comprising a swivelling table mounted on said bed for adjustment about an axis passing through the point of contact between said grinding wheel and the surface of a work piece, a carriage slidably mounted on said table, a headstock and footstock on said carriage for rotatably

supporting the work piece thereon, means for effecting relative transverse and longitudinal movement between said carriage and grinding wheel, means to effect said longitudinal movement intermittently to locate spaced portions of a work piece successively in operative relation to the grinding wheel comprising a spacing bar on said carriage having notches spaced in accordance with the spacing of said portions to be ground and a plunger on said bed for engaging the notches in said spacing bar, said notches being wide enough to permit the entrance of said plunger in any position of angular adjustment of said carriage.

5. In a machine of the kind described, a bed, a work support, a grinding wheel support, a grinding wheel rotatably mounted thereon, means for effecting a longitudinal movement of one of said supports relative to the other, means to effect said movement intermittently to successively position said grinding wheel and spaced portions of a work piece in operative relation including a spacing bar having notches spaced in accordance with the spacing of said portions to be ground and a plunger for engaging the notches in said spacing bar, means for effecting a swivelling movement of said work support in order to grind tapered surfaces in different directions on some of said portions including a member mounted on said bed for angular adjustment about a vertical axis which is tangent to the face of the grinding wheel when said grinding wheel is in work engaging position, said work support being slidably mounted on said angularly adjustable member, means for swivelling said angularly adjustable member to place each of said spaced portions in predetermined angular relation to said grinding wheel, including a motor attached to said member and actuated in response to movement of said plunger.

6. In a machine of the kind described comprising a bed, a grinding wheel support slidably mounted thereon, a grinding wheel rotatably mounted on said support, a work support comprising a swivelling table mounted on said bed for adjustment about an axis passing through the point of contact between said grinding wheel and the surface of a work piece, a carriage slidably mounted on said table, a headstock and footstock on said carriage for rotatably supporting the work piece thereon, means for effecting relative transverse and longitudinal movement between said carriage and said grinding wheel, means to effect said longitudinal movement intermittently to locate spaced portions of a work piece successively in operative relation to the grinding wheel and said swivel axis and means actuated by the means controlling said intermittent movement for swivelling said work support in opposite directions whereby the surfaces of said spaced portions are ground to a taper in opposite directions.

7. In a machine of the kind described comprising a bed, a grinding wheel support slidably mounted thereon, a grinding wheel rotatably mounted on said support, a work support comprising a swivelling table mounted on said bed for adjustment about an axis in the plane of the grinding wheel, a carriage slidably mounted for longitudinal movement on said table, a headstock and footstock on said carriage for rotatably supporting a work piece thereon, means for effecting relative transverse and longitudinal movement between said carriage and said grinding wheel, means to effect said longitudinal movement intermittently to locate spaced portions of a work piece successively in operative relation to the grinding wheel and said swivel axis and means including a motor actuated by the means for effecting said intermittent movement, for swivelling said work support in opposite directions whereby the surfaces of said spaced portions are ground to a taper in opposite directions.

8. In a machine of the kind described, a bed, a work support, a grinding wheel support, a grinding wheel rotatably mounted thereon, means for effecting longitudinal movement of said work support, means to effect said movement intermittently to successively position said grinding

wheel and spaced portions of a work piece in operative relation, means for effecting a swivelling movement of said work support in order to grind tapered surfaces in different directions on some of said portions including a member mounted on said bed for angular adjustment, a fixed pivotal mounting for said member having a vertical axis substantially tangent to the peripheral surface of the grinding wheel when said wheel is in contact with a work piece, said work support being slidably mounted on said angularly adjustable member for movement thereon in a direction determined by said angular adjustment so that each of said portions is presented to the grinding wheel in the same longitudinal and transverse position relative to said axis.

9. In a machine of the kind described, a bed, a grinding wheel support, a grinding wheel rotatably mounted thereon, a member mounted on said bed for angular adjustment a pivotal mounting therefor in said bed having a vertical axis passing substantially through the point of contact between work and wheel, a work support slidably mounted for movement on said angularly adjustable member in a direction determined by said angular adjustment,

means to effect said longitudinal movement intermittently to successively position said grinding wheel and spaced portions of a work piece in operative relation for grinding, means for swivelling said pivotally mounted member in opposite directions for grinding tapered surfaces on said portions in opposite directions, so that each of said portions of the work piece is presented to the grinding wheel in the same longitudinal and transverse position relative to said vertical axis.

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