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(54) **IMPROVEMENTS IN AND RELATING TO GRINDING MACHINES**

VERBESSERUNGEN AN/UND IM ZUSAMMENHANG MIT SCHLEIFMASCHINEN

AMELIORATIONS APPORTEES ET SE RAPPORTANT A DES MEULEUSES

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**EP-A- 0 744 243**
**WO-A-84/04480**
**WO-A-96/03257**
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- **Presentation SCHAUDT/MERCEDES of 11.05.1995**
- **Catalogue SCHAUDT-SMW"CF41CBN", marked 0396 (page 16 )**
- **SCHAUDT-SMW invitation to Open Days from 4th to 8th March 1996**
- **SCHAUDT-SMW list of invitees as of 08.02.1996 to Open Days**
- **Fertigung, May 1996 , pages 86 and 88**
- **Fertigungsmaschinen und -verfahren May 1996 , pages 40 and 41**
- **Maschinenmarkt 13 May 1996, article Schaudt Maschinenbau GmbH**
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- **VDI-Z Integrierte Produktion, no date, "Schleifen von Nockenwellen"**
- **SCHAUDT-SMW internal communication of 23.02.1996 re. invitees**
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The file contains technical information submitted after the application was filed and not included in this specification

EP 0 896 552 B2

## Description

Field of invention

**[0001]** This invention concerns grinding machines as per the preamble of claim 1. An example of such a machine is disclosed by US 1 740 551 A.

Background to the invention

**[0002]** This invention is of particular application where a rough grinding operation is followed by a finish grinding operation which is performed by a smaller grinding wheel the diameter of which is such that one or more concave regions can be formed in the external surface of the cam profile during the finish grinding operation.

**[0003]** Whilst in theory a small diameter grinding wheel could be used for the rough grinding step, the wear which occurs on the grinding wheel when it is used for rough grinding is such that in practice the largest possible diameter grinding wheel is always used for rough grinding since the larger the diameter, the longer the normal life expectancy of the wheel.

**[0004]** In EP 744243A2 which is state of the art under Art. 54(3) and (4) EPC, is disclosed a grinding machine having first and second grinding wheels, the second grinding wheel being carried by an arm pivotable by a ram about the axis of the first grinding wheel.

Summary of the invention

**[0005]** According to of the present invention, there is 'provided a grinding machine in which a first grinding wheel is mounted on a wheelhead adaped to be moved towards and away from a workpiece for grinding same, a second grinding wheel is mounted at one end of an arm, the other end of which is pivotally mounted to the wheelhead about an axis parallel to the axis of rotation of the first grinding wheel, in which the first grinding wheel is larger than the second grinding wheel, and means is provided for pivoting the arm from an upper parked position into a lower grinding position in which the second grinding wheel engages a peripheral surface of the workpiece, characterised in that for rough grinding and subsequent final profile grinding of a cam including re-entrant positions, the arm is pivoted to the wheelhead to the rear of the first grinding wheel, the length of the arm being such that when the second wheel is in the grinding position, part of the second wheel is closer to the workpiece in the direction of movement of the wheelhead than is the corresponding part of the first grinding wheel so that as the wheelhead is advanced towards the workpiece to perform a grinding operation using the second wheel, the first wheel is kept well clear of the workpiece.

**[0006]** In this primary embodiment, a lateral shift of the wheelhead is necessary to align the second wheel with the same part of the workpiece as was engaged by the first larger grinding wheel before the second grinding wheel can be brought into operation. Alternative arrangements obviate the particular problem.

**[0007]** In the first variant, a long arm is employed so that the second grinding wheel is positioned in between the first grinding wheel and the workpiece with the two grinding wheels in the same plane, so that as the wheelhead is subsequently advanced towards the workpiece, it is the same part of the workpiece which is engaged by the second grinding wheel as was engaged by the first grinding wheel.

**[0008]** In a second variant, the arm is even longer and is still arranged to position the second grinding wheel in the same plane as the first grinding wheel, but because of the longer arm length, the arm is of sufficient length to position the second wheel on the opposite side of the workpiece from that of the first grinding wheel and a sufficient distance is provided between the two grinding wheels to permit the workpiece to rotate and for the wheelhead to move in known manner so as to maintain contact between the workpiece and one of the grinding wheels without the workpiece coming into engagement with the other grinding wheel, whilst one of the grinding wheel is grinding and then vice versa, whilst the other of the grinding wheels is grinding.

**[0009]** In a modification to the second variant mentioned above, the second grinding wheel is located in position beyond the workpiece before the first wheel is advanced and a rough grinding operation is performed, and by appropriate movement of the wheelhead one or the other of the grinding wheels engage the workpiece.

**[0010]** The arm carrying the second grinding wheel may itself be mounted on a slideway on the wheelhead so as to be movable in a direction towards and away from the workpiece on the opposite side thereof from that engaged by the first grinding wheel, in parallel with the sliding movement of the wheelhead. As rough grinding is coming to an end and before the wheelhead is fully retracted so as to disengage the first grinding wheel from the workpiece, the second wheel can be brought into engagement with the workpiece to finish grind the surface thereof (and in the case of a cam profile to introduce into the profile one or more concave regions whose radius is smaller than the radius of the larger grinding wheel).

**[0011]** After the finish grinding operation using the second grinding wheel, the arm mount is moved and the arm is pivoted so as to disengage the second wheel from the workpiece and permit the workpiece to be removed.

**[0012]** If a number of regions along the length of a workpiece are to be rough and finish ground, and if the diameter of workpiece is such as to allow the wheelhead to traverse the workpiece parallel to the axis of rotation of the latter without the grinding wheels or the arm interfering with intermediate sections of the workpiece, then indexing of the wheelhead can be performed so as to reposition the grinding wheels relative to the workpiece ready to rough and finish grind the next region

thereof.

**[0013]** Where the two grinding wheels are to be brought into alignment with either the second wheel between the first wheel and the workpiece, or with the first and second wheels on opposite sides of the workpiece, the pivoting arm may be arranged to one side or the other of the first grinding wheel, and a spindle may be provided at the outboard end of the pivoted arm which offsets the second grinding wheel to the side of the arm and into alignment with the first grinding wheel.

**[0014]** Altematively the arm may be configured and shaped so as to circumscribe the upper half of the first grinding wheel and any casing surrounding the latter, when the arm has been pivoted from the parked position into the grinding position.

**[0015]** Alternatively a bifurcated arm may be employed, the two parts lying on opposite sides of the first wheel.

Brief Description of drawings

**[0016]** Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figures 1 A and 1 B respectively show side views of a large diameter grinding wheel for rough grinding the profile of a cam and a small diameter grinding wheel for finish grinding the cam profile;

Figure 2 is a side view of a grinding machine in accordance with a first embodiment, in which the grinding wheels are offset;

Figure 3 is a side view of a second embodiment in which the grinding wheels are in alignment and both on one side of the cam; and

Figures 4 and 5 are respectively side and plan views of a third embodiment in which the smaller wheel is on the opposite side of the cam to the larger wheel.

Detailed Description

**[0017]** Referring first to Figures 1A and 1B there are shown side views of a cam 10 being ground respectively by a large grinding wheel 12 and a small grinding wheel 14. The wheels are fed in a horizontal direction towards and away from the cam to enable the wheels to follow the profile of the cam including its lobe portion 16.

**[0018]** The large wheel 12 of Figure 1 A is arranged to rough grind the cam to a modified profile in which only just sufficient stock is left for finish grinding. As the final profile of the cam has two concave or re-entrant portions 18, which have a radius smaller than that of the wheel 12, the latter cannot reach into the concave portions, so that a larger amount of stock is left in those portions at the completion of rough grinding.

**[0019]** The diameter of the large wheel 12 is chosen to be the largest which is compatible with an economic production of the cams. In contrast, the diameter of the small wheel 14 is determined by the minimum radius of the concave portion 18 of the cam profile.

**[0020]** Referring now to Figure 2 there is shown a grinding machine in accordance with one embodiment of the invention, having a wheelhead 20 on which is rotatably mounted the large wheel 12. Pivotally mounted on the wheelhead about an axis parallel to the rotational axis of the wheel 12 is a swinging arm 22 at whose outboard end is rotatably mounted the small grinding wheel 14. The arm 22 is offset from the wheel 12 and from any guard around the wheel. The small wheel 14 is likewise offset from the wheel 12, so that there is a lateral clearance between the wheels.

**[0021]** In the lowered position of the arm 22, shown in Figure 2, the wheel 14 arranged to finish grind a workpiece, for example a cam 10. Subsequently the arm 22 with the wheel 14 is adapted to be swung into an upper parked position, as shown in dotted lines, by retraction of a hydraulic ram 24 whose rod end is pivotally connected to an upper cranked portion 22A of the arm, and whose opposite end is pivotally connected to a remote part of the wheelhead 20, not shown.

**[0022]** In operation, rough grinding is performed with the arm 22 in its upper position, the wheelhead 20 being advanced forwards from the position shown until the large wheel 12 comes into engagement with the workpiece or cam 10. On completion of rough grinding, the wheelhead is retracted sufficiently to enable the ram 24 to bring the arm 22 into the lowered position in which the small wheel 14 is able to engage the cam for the finish grinding operation. Due to the offset between the two wheels it is necessary for the cam or the wheelhead to be moved laterally so that the small wheel 14 is brought into alignment with the cam.

**[0023]** Figure 3 shows an embodiment of the invention which is a modification of that described with reference to Figure 2.

**[0024]** Here the outboard end 22B of the arm is extended sufficiently to enable the small wheel 14 to be positioned in front of the large wheel 12 and in alignment therewith. With the use of this long arm, operation of the grinding machine is similar to that described above, except that when the small wheel 14 is lowered for finish grinding there is no need to realign the cam 10 with wheel 12, since the two wheels 12 and 14 are already in the same plane.

**[0025]** Referring now to Figures 4 and 5 there are shown side and plan views of a further embodiment. The swinging arm is here formed effectively in two halves as a bifurcated arm 30, the two halves being spaced apart to straddle each of the grinding wheels 12 and 14 with a sufficient clearance from the sides of the wheels.

**[0026]** The outboard end 30A of the arm 30 is extended even further than the end 22B of the swinging arm 22 of Figure 3, such that the small wheel 14 is disposed

on the side of the cam 10 opposite the large wheel 12. The distance between the two wheels requires to be such that, during rough grinding by the wheel 12, the small wheel 14 stands sufficiently clear of the cam 10 for it not to come into contact with the cam.

**[0027]** It should be noted that none of the rotary drives for the wheels 12 and 14 are shown, since such drives per se do not form part of the present invention.

**[0028]** The horizontal drive for the wheelhead 20 is shown in Figure 4 at reference 34. Although such drive may be used (as previously) for wheelhead movement for both grinding wheels, Figure 4 also shows a modification for driving the small wheel 14 into and out of engagement with the cam 10.

**[0029]** In this arrangementthe arm 30 is pivoted about a housing 32 which is slidably mounted on the wheelhead 20, movement of the housing being imparted by the drive mechanism 34 secured to the wheelhead.

**[0030]** Since the mechanism 34 moves the arm to the right, (as viewed in Figure 4), during an infeed movement of the small wheel 14 towards the cam, the rod of the ram 24 will be retracted so that any friction in the ram will not tend to cause a pivoting movement of the arm 30.

**[0031]** However, in a modification the pivoted mounting for the ram 24 may instead be formed as an extension of the housing 32 so that the ram moves with the housing during actuation of the drive mechanism 34, obviating any tendency for the arm 30 to be pivoted during such actuation.

**[0032]** In operation, as rough grinding is being completed before the wheelhead 20 retracts to disengage the large wheel 12 from the cam 10, the drive mechanism 34 begins to draw the small wheel 14 in to engagement with the cam for finish grinding. When finish grinding is complete the ram 24 retracts the arm 30 and wheel 14 to allow the cam to be removed and replaced by another workpiece or cam to be ground.

## Claims

1. A grinding machine in which a first grinding wheel (12) is mounted on a wheelhead (20) adapted to be moved towards and away from a workpiece (10) for grinding same, a second grinding wheel (14) is mounted at one end of an arm (22;30), the other end of which is pivotally mounted to the wheelhead about an axis parallel to the axis of rotation of the first grinding wheel, in which the first grinding wheel (12) is larger than the second grinding wheel (14), and means is provided for pivoting the arm (22) from an upper parked position into a lower grinding position in which the second grinding wheel (14) engages a peripheral surface of the workpiece (10), **characterised in that** for rough grinding and subsequent final profile grinding of a cam including reentrant positions, the arm (22) is pivoted to the wheelhead (20) to the rear of the first grinding wheel (12), the length of the arm being such that when the second wheel (14) is in the grinding position, part of the second wheel (14) is closer to the workpiece (10) in the direction of movement of the wheelhead than is the corresponding part of the first grinding wheel (12) so that as the wheelhead (20) is advanced towards the workpiece to perform a grinding operation using the second wheel (14), the first wheel (12) is kept well clear of the workpiece.

2. A grinding machine according to claim 1, wherein the arm (12) and second grinding wheel (14) are laterally offset from the first grinding wheel (12).

3. A grinding machine according to claim 1, wherein a long arm (22A) is employed so that the second grinding wheel (14) is positioned in between the first grinding wheel and the workpiece (10) with the two grinding wheels in the same plane, so that as the wheelhead (20) is subsequently advanced towards the workpiece (10), it is the same part of the workpiece (10) which is engaged by the second grinding wheel (14) as was engaged by the first grinding wheel (12).

4. A grinding machine according to claim 1 or claim 2, wherein the arm (30) is of sufficient length to position the second wheel (14) on the opposite side of the workpiece (10) from that of the first grinding wheel (12) and a sufficient distance is provided between the two grinding wheels to permit the workpiece (10) to rotate and for the wheelhead (20) to move in known manner so as to maintain contact between the workpiece and one of the grinding wheels without the workpiece coming into engagement with the other grinding wheel.

5. A grinding machine according to claim 4, wherein the second grinding wheel (14) is located in position beyond the workpiece (10) before the first wheel is advanced and a rough grinding operation is performed.

6. A grinding machine according to claim 4 or claim 5, wherein the arm (30) carrying the second grinding wheel (14) is mounted on a slideway (32) on the wheelhead (20) so as to be movable in a direction towards and away from the workpiece (10) on the opposite side thereof from that engaged by the first grinding wheel (12), in parallel with the sliding movement of the wheelhead (20).

7. A grinding machine according to any of claims 3 to 6 claims, wherein the arm is arranged on one side of the first grinding wheel (12), and a spindle is provided at the outboard end of the arm to offset the second grinding wheel (14) to the side of the arm

and into alignment with the first grinding wheel (12).

**8.** A grinding machine according to any one of claims 1 to 6, wherein the arm is configured and shaped so as to circumscribe the upper half of the first grinding wheel (12) and any casing surrounding the latter, when the arm has been pivoted from the parked position into the grinding position.

**9.** A grinding machine according to any one of claims 1 to 6 or 8, wherein a bifurcated arm (30) is employed, the two parts lying on opposite sides of the first wheel.

**Patentansprüche**

**1.** schleifmaschine, bei der eine erste Schleifscheibe (12) auf einem Schleifkopf (20) befestigt ist, der auf ein zu schleifendes Werkstück zu und von diesem weg bewegbar ist, eine zweite Schleifscheibe (14) am einen Ende eines Armes (22; 30) befestigt ist, dessen anderes Ende an dem Schleifköpf schwenkbar um eine Achse parallel zur Rotationsachse des ersten Schleifrades befestigt ist, wobei die erste Schleifscheibe (12) größer als die zweite Schleifscheibe (14) ist, und bei der eine Vorrichtung vorgesehen ist, die den Arm (22) aus einer oberen Parkposition in eine untere Schleifposition verschwenkt, in der die zweite Schleifscheibe (14) mit einer Umfangsfläche des Werkstückes (10) in Eingriff kommt, **dadurch gekennzeichnet, dass** zum Grobschleifen und nachfolgenden Endprofil-Schleifen eines Nockens einschließlich von einspringenden Positionen der Arm (22) mit dem Schleifkopf (20) gegen die Rückseite der ersten Schleifscheibe (12) schwenkbar ist, die Länge des Armes so ausgelegt ist, dass dann, wenn die zweite Schleifscheibe (14) die Schleifposition einnimmt, ein Teil der zweiten Schleifscheibe (14) sich näher dem Werkstück (10) in Richtung der Bewegung des Schleifkopfes befindet als der entsprechende Teil der ersten Schleifscheibe (12), derart, dass dann, wenn der Schleifkopf (20) gegen das Werkstück vorgeschoben wird, um einen Schleifvorgang unter Verwendung der zweiten Schleifscheibe (14) durchzuführen, die erste Schleifscheibe (12) im Abstand von dem Werkstück gehalten wird.

**2.** Schleifmaschine nach Anspruch 1, bei der der Arm (12) und die zweite Schleifscheibe (14) seitlich von der ersten Schleifscheibe (12) versetzt sind.

**3.** Schleifmaschine nach Anspruch 1, bei der ein langer Arm (22A) verwendet wird, um die zweite Schleifscheibe (14) zwischen der ersten Schleifscheibe und dem Werkstück (10) zu positionieren, wobei die beiden Schleifscheiben in der gleichen Ebene angeordnet sind, derart, dass dann, wenn der Schleifkopf (20) anschließend gegen das Werkstück (10) vorgeschoben wird, der gleiche Teil des Werkstückes (10) in Eingriff mit der zweiten Schleifscheibe (14) kommt, der in Eingriff mit der ersten Schleifscheibe (12) gestanden hatte.

**4.** Schleifmaschine nach Anspruch 1 oder 2, bei der der Arm (30) eine ausreichend große Länge besitzt, um die zweite Schleifscheibe (14) auf der entgegengesetzten Seite des Werkstückes (10) zu der der ersten Schleifscheibe (12) zu positionieren, und ein ausreichend großer Abstand zwischen den beiden Schleifscheiben vorgesehen ist, damit das Werkstück (10) eine Rotationsbewegung ausführen, und der Schleifkopf (20) sich in bekannter Weise so verschieben kann, dass ein Kontakt zwischen dem Werkstück und einer der Schleifscheiben erfolgt, ohne dass das Werkstück in Eingriff mit der anderen Schleifscheibe kommt.

**5.** Schleifmaschine nach Anspruch 4, bei der die zweite Schleifscheibe (14) in einer Position jenseits des Werkstückes (10) angeordnet ist, bevor die erste Schleifscheibe vorgeschoben wird, und ein Grob-Schleifvorgang durchgeführt wird.

**6.** Schleifmaschine nach Anspruch 4 oder 5, bei der der Arm (30), der die zweite Schleifscheibe (14) aufnimmt, auf einer Gleitbahn (32) auf dem Schleifkopf (20) so befestigt ist, dass er in einer Richtung auf das Werkstück (10) zu und von diesem weg auf der entgegengesetzten Seite zu der, die mit der ersten Schleifscheibe (12) in Eingriff steht, parallel zu der Gleitbewegung des Schleifkopfes (20) bewegt wird.

**7.** Schleifmaschine nach einem der Ansprüche 3 - 6, bei der der Arm auf einer Seite der ersten Schleifscheibe (12) angeordnet ist, und eine Spindel an dem Außenende des Armes vorgesehen ist, um die zweite Schleifscheibe (14) nach der Seite des Armes und in Ausrichtung mit der ersten Schleifscheibe (12) zu versetzen.

**8.** Schleifmaschine nach einem der Ansprüche 1 - 6, bei der der Arm so ausgebildet und geformt ist, dass er die obere Hälfte der ersten Schleifscheibe (12) und ein diese Schleifscheibe umgebendes Gehäuse umschreibt, wenn der Arm aus der Parkposition in die Schleifposition verschwenkt worden ist.

**9.** Schleifmaschine nach einem der Ansprüche 1 - 6 oder 8, bei der ein gegabelter Arm (30) verwendet wird und die beiden Teile auf entgegengesetzten Seiten der ersten Schleifscheibe liegen.

**Revendications**

1. Une meuleuse dans laquelle une première meule (12) est montée sur une poupée porte-meule (20), adaptée pour être avancée vers une pièce à usiner (10) et éloignée de celle-ci pour sa rectification, une deuxième meule (14) étant montée sur une des extrémités d'un bras (22 ; 30), l'autre extrémité duquel est montée par pivotement sur la poupée porte-meule, autour d'un axe parallèle à l'axe de rotation de la première meule, dans laquelle la première meule (12) est plus grande que la deuxième meule (14), et un dispositif assure le pivotement du bras (22) d'une position de repos supérieure à une position de rectification inférieure, dans laquelle la deuxième meule (14) s'engage avec le pourtour de la pièce (10), et **caractérisée par le fait que**, pour la rectification de dégrossissage puis la rectification de finissage du profil d'une came, y compris les positions de contre dépouille, le bras (22) pivote vers la poupée porte-meule (20), à l'arrière de la première meule (12), la longueur du bras étant telle que lorsque la deuxième meule (14) se trouve dans la position de rectification, une partie de la deuxième meule (14) est plus proche de la pièce (10), dans le sens du déplacement de la poupée porte-meule, que la partie correspondante de la première meule (12), de sorte que lorsque la poupée porte-meule (20) avance vers la pièce pour effectuer une opération de rectification avec la deuxième meule (14), la première meule (12) soit bien dégagée de la pièce.

2. Une meuleuse conforme à la revendication 1, dans laquelle le bras (12) et la deuxième meule (14) sont excentrés latéralement par rapport à la première meule (12).

3. Une meuleuse conforme à la revendication 1, dans laquelle un long bras (22A) est utilisé pour positionner la deuxième meule (14) entré la première meule et la pièce (10), avec les deux meules dans le même plan, de sorte que, lorsque la poupée porte-meule (20) avance vers la pièce (10), la zone de la pièce (10) en contact avec la deuxième meule (14) est la même que celle qui était en contact avec la première meule (12).

4. Une meuleuse conforme à la revendication 1 ou à la revendication 2, dans laquelle le bras (30) est suffisamment long pour positionner la deuxième meule (14) du côté de la pièce (10) opposé à la première meule (12), et il existe une distance suffisante entre les deux meules pour permettre la rotation de la pièce (10) et le déplacement de la poupée porte-meule (20) d'une façon connue, de façon à maintenir le contact entre la pièce et une des meules, sans que la pièce ne s'engage avec l'autre meule.

5. Une meuleuse conforme à la revendication 4, dans laquelle la deuxième meule (14) est placée au-delà de la pièce (10), avant l'avance de la première meule et l'exécution d'une rectification de dégrossissage.

6. Une meuleuse conforme à la revendication 4 ou à la revendication 5, dans laquelle le bras (30), portant la deuxième meule (14), est monté sur une glissière (32) sur la poupée porte-meule (20), de façon à pouvoir être avancé vers la pièce (10), et éloigné de celle-ci, du côté opposé au côté sur lequel la première meule (12) engage la pièce, et parallèlement au mouvement coulissant de la poupée porte-meule (20).

7. Une meuleuse conforme aux revendications 3 à 6, dans laquelle le bras est disposé d'un côté de la première meule (12), et une broche est placée sur le côté extérieur du bras pour décaler la deuxième meule (14) vers le côté du bras et dans l'axe de la première meule (12).

8. Une meuleuse conforme aux revendications 1 à 6, dans laquelle le bras est configuré et façonné de façon à circonscrire la moitié supérieure de la première meule (12) et le logement entourant éventuellement cette dernière, lorsque le bras a pivoté de sa position de repos à sa position de rectification.

9. Une meuleuse conforme aux revendications 1 à 6 ou 8, dans laquelle un bras en Y (30) est utilisé, ses deux moitiés étant placées des côtés opposés de la première meule.

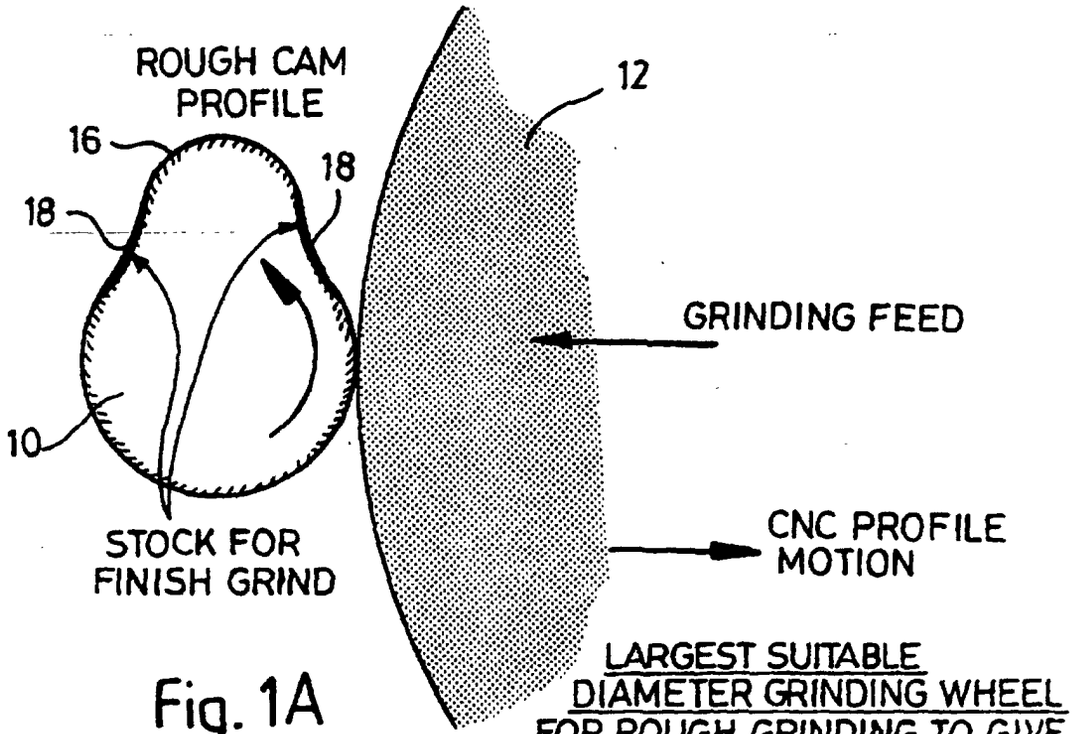
ROUGH CAM PROFILE
16
18
18
10
12
GRINDING FEED
CNC PROFILE MOTION
STOCK FOR FINISH GRIND
LARGEST SUITABLE DIAMETER GRINDING WHEEL FOR ROUGH GRINDING TO GIVE ECONOMIC PRODUCTION

Fig. 1A

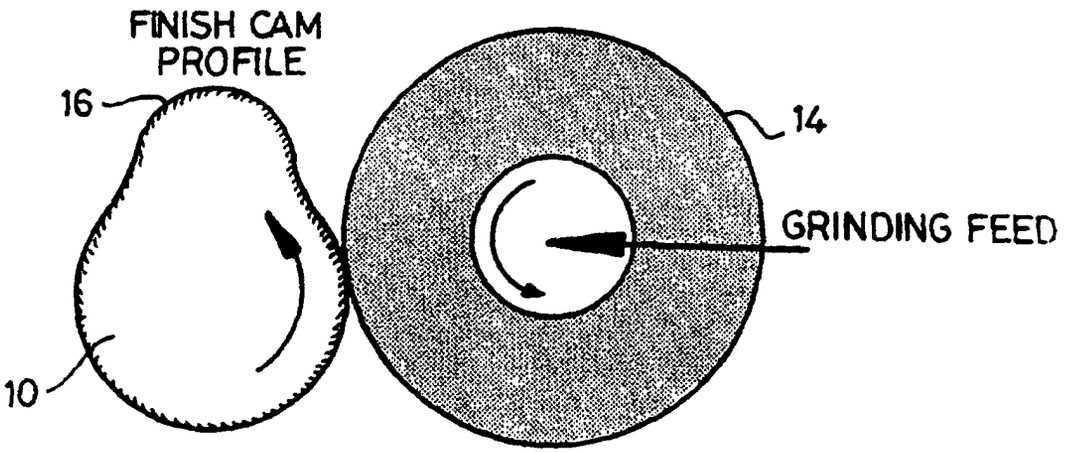
FINISH CAM PROFILE
16
10
14
GRINDING FEED
CNC PROFILE MOTION
GRINDING WHEEL DIAMETER DETERMINED BY FINISH CAM PROFILE

Fig. 1B

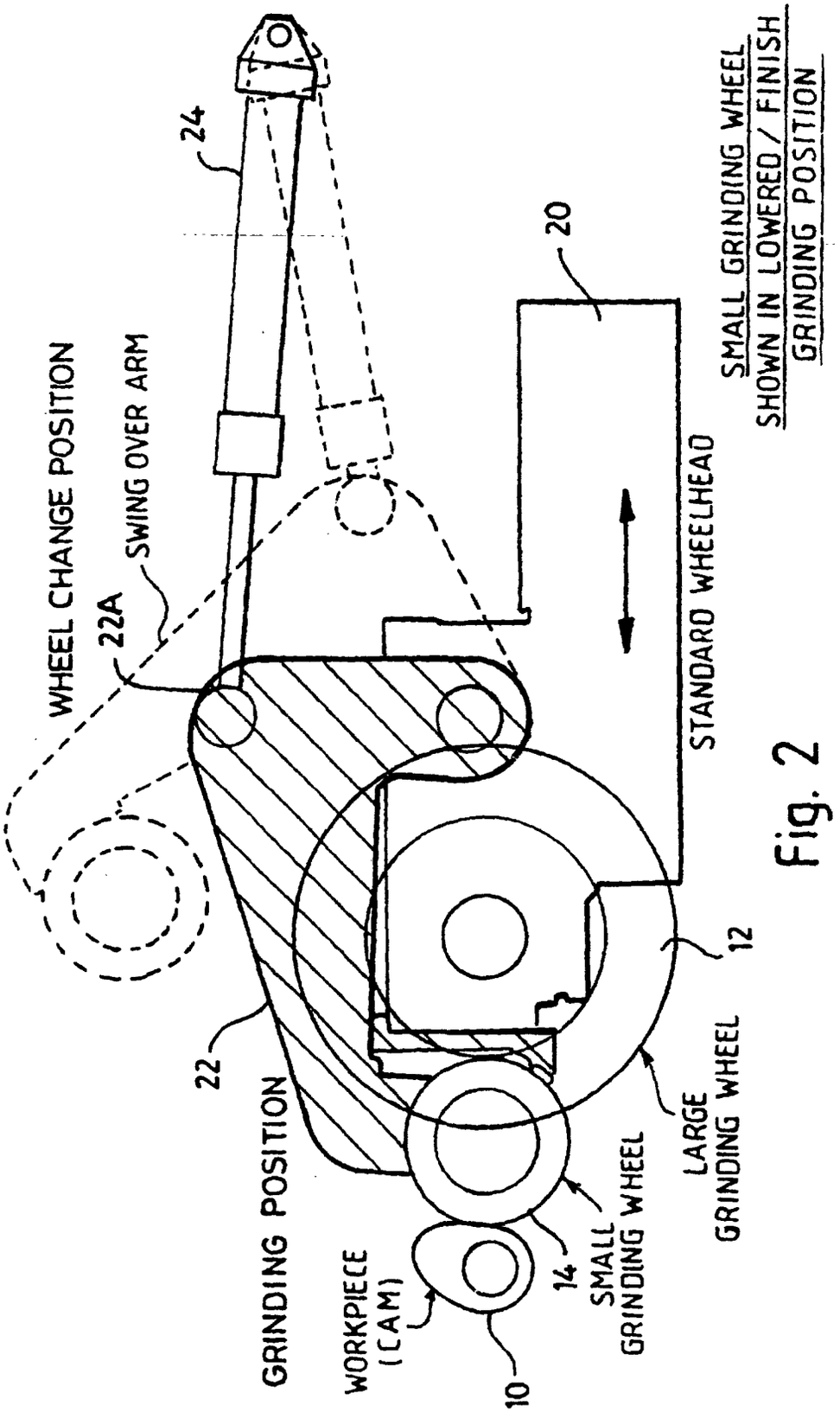
WHEEL CHANGE POSITION
SWING OVER ARM
22A
24
20
SMALL GRINDING WHEEL
SHOWN IN LOWERED / FINISH
GRINDING POSITION
STANDARD WHEELHEAD
12
22
GRINDING POSITION
WORKPIECE
(CAM)
10
14
SMALL
GRINDING WHEEL
LARGE
GRINDING WHEEL

Fig. 2

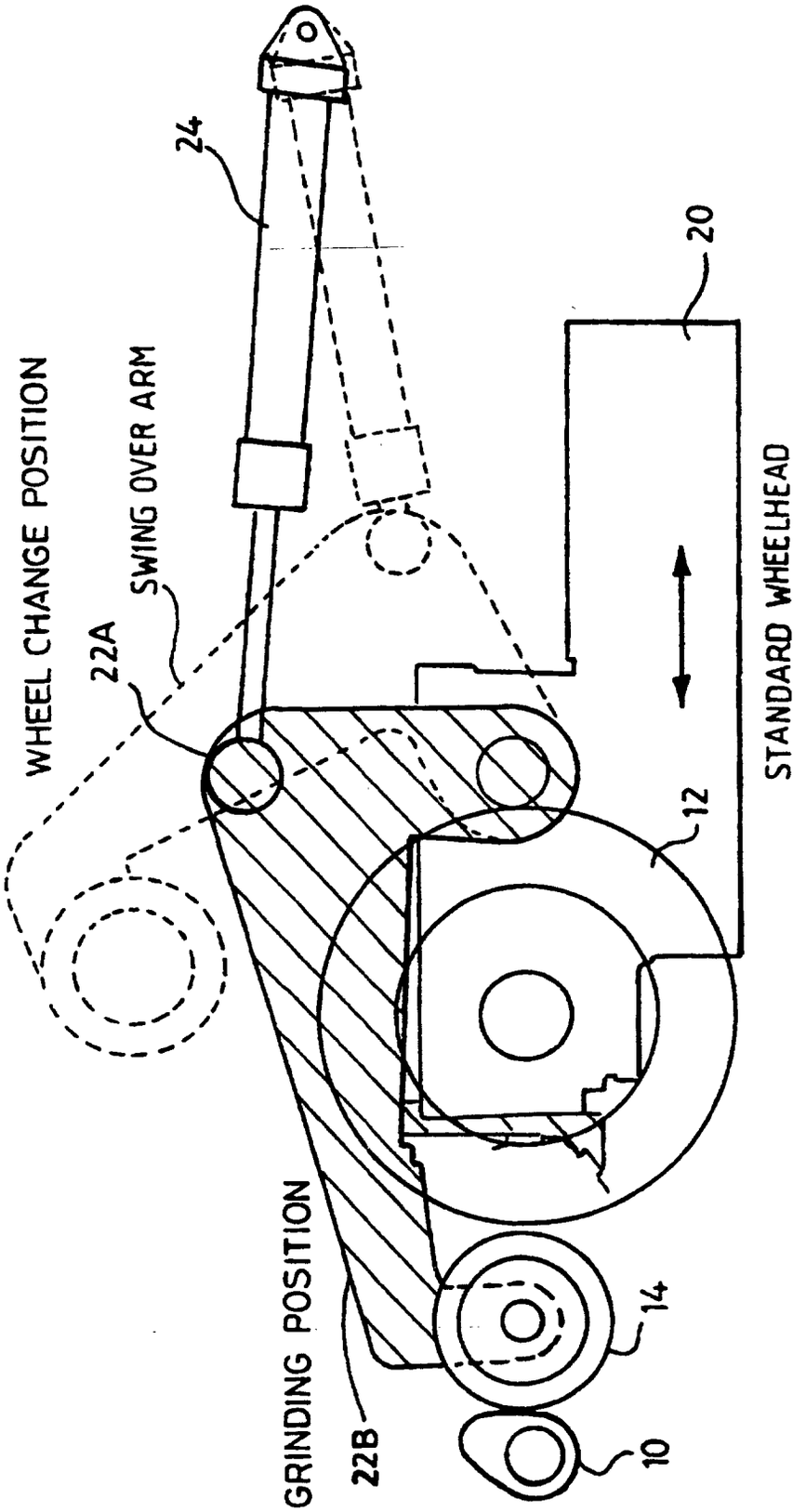
WHEEL CHANGE POSITION
SWING OVER ARM
22A
24
20
STANDARD WHEELHEAD
12
14
10
GRINDING POSITION
22B

Fig. 3

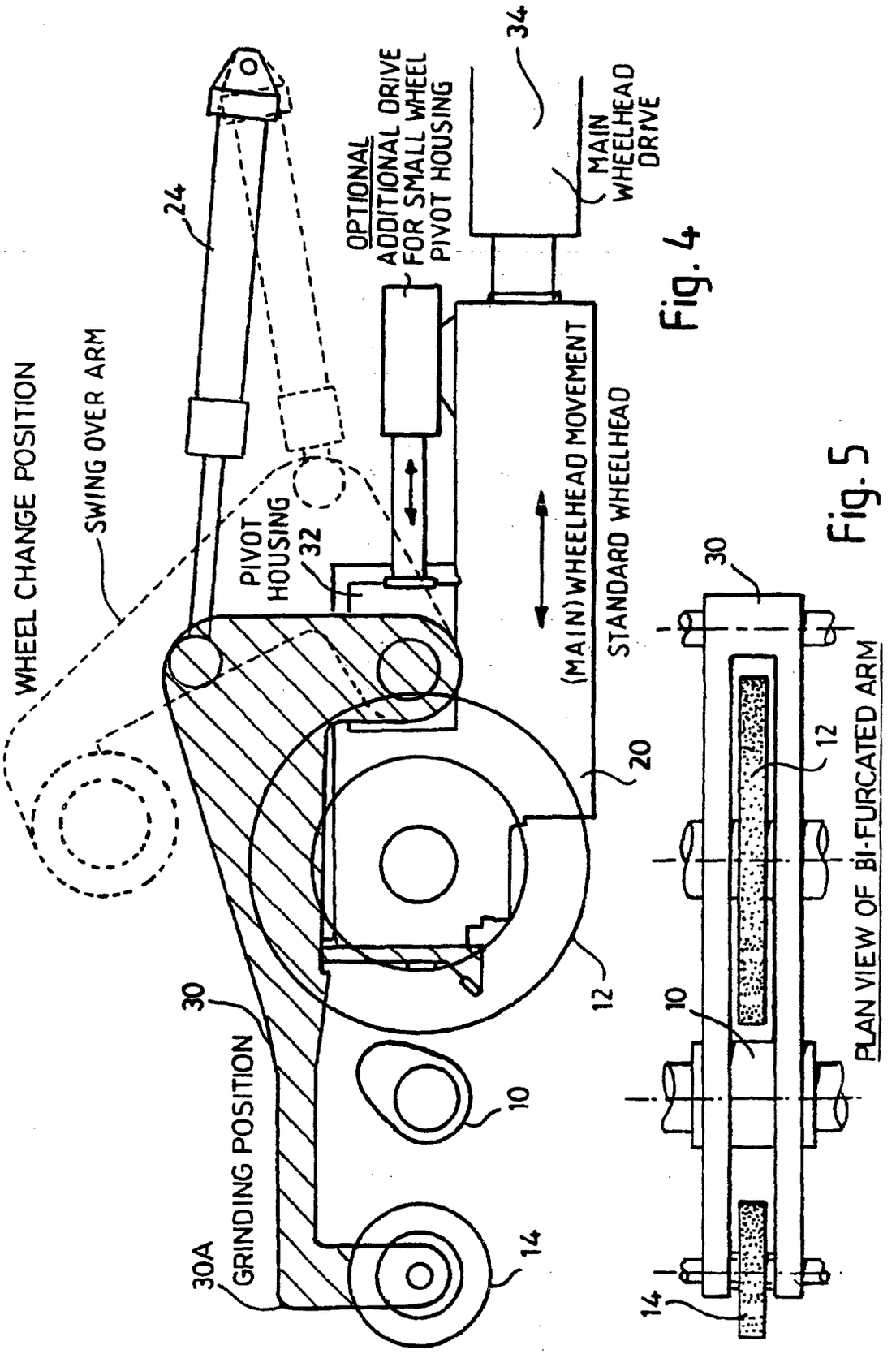
WHEEL CHANGE POSITION
SWING OVER ARM
24
OPTIONAL
ADDITIONAL DRIVE
FOR SMALL WHEEL
PIVOT HOUSING
34
MAIN
WHEELHEAD
DRIVE
PIVOT
HOUSING
32
(MAIN) WHEELHEAD MOVEMENT
STANDARD WHEELHEAD
20
12
30
GRINDING POSITION
30A
10
14

Fig. 4


30
12
10
14
PLAN VIEW OF BI-FURCATED ARM

Fig. 5