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Application No.: 79 103 163.6
Publication No.: 0 024 445
Title of invention: Tunnel boring machine

Classification: E21D 9/10

D E C I S I O N
of 11 June 1991

Proprietor of the patent: Voest-Alpine Aktiengesellschaft

Opponent: Gewerkschaft Eisenhütte Westfalia GmbH

Headword:

EPC Articles 54(3), 56, 123

Keyword: "Inventive step (yes)"
"Closest prior art: earlier European patent application"
"Two-part form of Claim 1 inappropriate"

Headnote



Case Number : T 172/88 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 11 June 1991

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Decision under appeal : Decision of Opposition Division of the European
Patent Office dispatched on 29 March 1988
rejecting the opposition filed against European
patent No. 24 445 pursuant to Article 102(2)
EPC.

Composition of the Board :

Chairman : C. Andries
Members : H. Seidenschwarz
L. Mancini

Summary of Facts and Submissions

- I. European patent No. 0 024 445 comprising four claims was granted on 27 July 1983 in response to European patent application No. 79 103 163.6 filed on 27 August 1979.
- II. An opposition was filed against the European patent requesting it be revoked on the grounds of lack of inventive step.

The following documents were referred to:

D1: DE-B-1 921 092

D2: DE-B-2 107 289

- III. After considering the grounds for opposition, the Opposition Division rejected the opposition by the decision dispatched on 29 March 1988.
- IV. The Opponent (Appellant) filed an appeal against the decision on 26 April 1988, paying the appeal fee simultaneously. The statement of grounds was received on 22 July 1988.

In this statement and in a letter in response to a communication of the Board of Appeal he cited the following documents for the first time:

D3: DE-A-2 054 298

D4: DE-B-2 437 683

D5: DE-B-2 248 785

D6: DE-A-2 741 637

D7: DE-C-1 658 764

D8: Prospectus "Warner & Swasey" (1966).

V. The Proprietor (Respondent) contested the Opponent's arguments and emphasised that the documents D3 to D8 were filed too late and did not disclose any more information than documents D1 and D2.

VI. Oral proceedings took place on 11 June 1991.

(i) The Proprietor filed a new set of claims (1 to 3), a new description (pages 2 to 5) and drawings (sheets 1 to 4).

(ii) The Opponent brought forward for the first time

a) that Claim 1 has been amended with respect to Claim 1 as originally filed in such a way that these amendments contravene Article 123(2) EPC; namely

1) that the direction of the longitudinal axis about which a mounting ring can rotate is not defined anymore in Claim 1 (contrary to Claim 1 of the application as filed: "...bearing axis parallel to that of a tunnel to be bored, ...");

2) that the direction of the axis of the boom pivot on the mounting ring is not defined anymore in Claim 1 (contrary to Claim 1 of the application as filed: "a boom pivot axis is located in a plane transverse to said bearing axis");

3) that the position of the boom actuating means as defined in the characterising portion of Claim 1 is vague in comparison with the disclosure of claim 2 of the application as

filed ("...rearward boom actuator axis ... and in proximity to said bearing axis"), which has been deleted during examination.

- b) that claim 1 does not contain any information on the specific constructional relationship of the different features. Such information is necessary to teach the person skilled in the art of the correct lever arrangement and the load transmission linked therewith, and to allow him to carry out the invention.

(iii) The arguments of the Opponent with respect to the inventive step of the subject-matter of Claim 1 can be summarised as follows:

- 1) The general state of the art at the priority date is known from the description of the prior art in document US-A-4 203 626 (columns 1 and 2) which was published too late and which corresponds to the earlier European patent application No. 79 103 162.8, publication No. 0 014 733; document D9 cited in the specification of the patent in suit.

- 2) The constructional conception underlying the subject-matter of Claim 1 is already known from various types of tunnel boring or cutting machines according to the documents D1 to D4 and D7. In particular from these documents it becomes clear that said constructional conception is always the same in all machines, although the technical problems to be solved according to each of these documents are different from the technical problem to be solved by the subject-matter as claimed in the patent in suit.

3) The conditions and the problems arising during the digging of tunnels, which are all the same for the various types of tunnel boring or cutting machines, are common knowledge to the person skilled in the art. Therefore, the person skilled in the art knows that the pivot bearing carrying a boom-bucket assembly and the boom actuating means must be big enough to be able to provide sufficient breakout force at the bucket edge all over the cutting area and to take up the resulting reaction forces. Indeed, it is an obvious prerequisite in digging tunnels to provide not only a sufficient breakout force in all points of the cutting area of the bucket, but also a uniform breakout force across the cutting area. Therefore, it is obvious to dispose the boom actuating means behind the axis of the boom pivot at the mounting ring. The application of a constructional conception (cf. preceding paragraph 2) already employed in known machines for the same purpose with corresponding effect to a similar machine does not involve an inventive step.

(iv) According to the Proprietor it is the object of the present invention to improve the prior art known from the earlier European patent application, i.e. document D9. Documents D1 and D2 do not mention the specific technical problem to be solved by the subject-matter of Claim 1 of the patent in suit and do not give any hint towards features solving this specific technical problem. The disclosure of the other documents D3, D4 and D7 cited by the Opponent during the oral proceedings does not go beyond that of the documents D1 and D2.

Furthermore, having regard to the objection relating to the insufficiency of the disclosure (cf. above section VI (ii) b)), the Proprietor referred to Claim 1, the description and particularly Figures 1 to 3 of the patent in suit which provide the person skilled in the art with sufficient information for carrying out the invention.

VII. The new Claim 1 reads as follows:

"A tunnel boring machine comprising:

a cylindrical shield (11),

a bulkhead (18) mounted in said shield for slidable longitudinal movement therewith,

a mounting ring (23) connected to said bulkhead (18) for rotational movement relative thereto about a longitudinal axis,

a boom (25) pivotally connected to said mounting ring (23),

a dipper member (27) pivotally connected to said boom (25),

a bucket (29) pivotally connected to said dipper member (27), boom actuating means (32) connected between said mounting ring (23) and said boom (25),

dipper member actuating means (35) connected between said boom (25) and said dipper member (27),

bucket actuating means (37) connected between said dipper member (27) and said bucket (29), wherein

said boom actuating means (32) is disposed within and extends through said mounting ring (23) with its rearward end being disposed and connected substantially behind said mounting ring (23) to an inner housing member (53) secured to the mounting ring about a pivotal axis transverse to the axis of the mounting ring, and wherein said actuating means (32, 35 and 37) comprise extendible piston-cylinder assemblies."

VIII. The Opponent requested that the decision under appeal be set aside and the European patent No. 24 445 be revoked.

The Proprietor requested that the appeal be dismissed and the patent be maintained in a form as amended during the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. Amendments

2.1 Claim 1 as filed during the oral proceedings differs from the Claim 1 of the patent as granted,

- firstly by adding the content of Claim 3 of the patent as granted;
- secondly by correcting an inconsistency between Claim 1 of the patent as granted and the description of said patent (cf. EP-B-0 024 445, column 4, line 54 to column 5, line 2; column 6, lines 18 to 29), namely by indicating that the mounting ring is connected to the bulkhead for rotational movement relative thereto, and
- thirdly by deleting the wording "characterized in that".

2.1.1 The first and third amendments do not give rise to any objection.

2.1.2 Concerning the amendment relating to the indicated inconsistency, the Board emphasises that it is unequivocally clear from the whole content of the patent, i.e. not only from the description (cf. the above cited

passages), but also from the drawings (e.g. Fig. 2: bearing 42 located between the rotatable mounting ring 23 and the fixed bulkhead 18), that the mounting ring is rotatable, whereas the bulkhead is fixed non-rotatable, so that it is correct to define the relationship between the features as it is defined now in Claim 1.

The amendment does not broaden the present Claim 1 since its meaning is the same as that of Claim 1 of the patent as granted on its proper construction in the context of the specification. Therefore, also this amendment does not contravene Article 123(2) and (3) EPC (cf. T 271/84, OJ EPO 1987, 405, section 2).

2.2 Dependent claims 2 and 3 are identical with the dependent claims 2 and 4 of the patent as granted.

2.3 Concerning the amendments made during the examining procedure and contested by the Opponent (cf. above point VI(ii) 1) to 3) the following is observed:

- From the description it is evident and implicit that the "longitudinal axis" mentioned in Claim 1 corresponds to the axis of the tunnel to be bored, particularly since the expression "longitudinal movement" has already been used in Claim 1 itself (column 7, lines 25 to 27) in relation with the movement of the cylindrical shield.
- According to present Claim 1, the rearward end of the boom actuating means is connected to an inner housing member secured to the mounting ring about a pivotal axis transverse to the axis of the mounting ring (cf. Claim 1: column 7, lines 45 to 51). Since the boom is also pivotally connected to the mounting ring (cf. Claim 1: column 7, lines 31 and 32) it is evident and

implicit for the person skilled in the art that the axis of this pivot (boom-mounting ring) must be located automatically parallel to said pivotal axis of the boom actuating means and, therefore, transverse to the longitudinal axis, enabling thereby the boom actuating means to move the boom.

- Claim 1 (column 7, lines 45 to 51) specifies clearly the position of the boom actuating means with respect to the mounting ring. This position as well as the connection of the rearward end of the boom actuating means to the mounting ring are specified by the description (page 5, line 40 to page 6, line 20) in combination with Figure 2 of the application as filed, as well as by the content of Claim 2 of the application as filed. The fact that Claim 2 has been deleted during the examining procedure cannot be considered as an unallowable amendment of Claim 1 within the meaning of Article 123(2) EPC.

2.4 The amendments on page 2 (column 1) of the description correspond to the amendments in Claim 1, and do not give rise to any objection.

2.5 The patent in suit, in its present form, complies with Article 123(2) and (3) EPC.

3. Closest state of the art

During the oral proceedings the parties agreed that a tunnel boring machine known from the earlier European patent application, i.e. document D9 and comprising a cylindrical shield and an excavator mounted in the outer end of said cylindrical shield, has to be considered as the closest state of the art.

The excavator includes:

- a bulkhead being movable axially in said cylindrical shield;
- a mounting ring mounted on the bulkhead and being rotatable relative to the bulkhead about the longitudinal axis of the tunnel boring machine;
- a boom pivotally connected with its inner end to said mounting ring;
- a dipper member pivotally connected to the outer end of said boom;
- a bucket pivotally connected to the outer end of said dipper member;
- a piston-cylinder assembly pivotally connected at one end to the mounting ring and at the other end to said boom for moving the outer end of said boom about the pivot connection thereof to said mounting ring toward and away from said mounting ring;
- a piston-cylinder assembly pivotally connected at one end to said boom and at the other end to said dipper member for moving said dipper member about the pivot connection thereof to said boom toward and away from the longitudinal axis of the tunnel boring machine, and
- piston-cylinder assembly pivotally connected at one end to said dipper member and at the other end to said bucket and operable to pivot said bucket about the pivot connection thereof to said dipper member to move the outer cutting edge of said bucket in a clawing action against material being removed by the tunnel boring machine.

The purpose of this known design is, according to document D9, to provide a generally strong, more uniform breakout force at all positions of the cutting edge of the bucket across the cutting face.

4. Problem and solution

4.1 The technical problem to be solved is to further improve the excavator assembly according to the earlier European patent application (D9) by supplying a significantly larger breakout force at the outer periphery of the cutting area of the bucket and by providing an even more uniform breakout force (cf. EP-B-0 024 445, column 1, lines 22 to 25 and 41 to 45; column 6, line 64 to column 7, line 7 and lines 12 to 14; Fig. 4, lines 63 and 65).

4.2 According to the teaching of Claim 1 this problem is essentially solved by connecting the rearward end of the boom-actuating piston-cylinder assembly to a pivotal axis located not only inside an inner housing member secured to the mounting ring, but also substantially behind the mounting ring.

The connection of the piston-cylinder assembly right behind the pivot point of the inner end of the boom at the mounting ring increases the lever arm for moving the boom and, consequently, also the leverage of said boom. This results (as shown in Figure 4, lines 63 and 65) not only in an overall increase of the general uniform breakout force at the cutting edge of the bucket throughout the cutting face, particularly at the outer periphery of the cutting area of the bucket compared to the excavator assembly known from the earlier European patent application, but also in an even more uniform breakout force.

4.3 There is no reason for the Board to doubt the results as presented in Fig. 4, particularly since the Opponent did not criticise the obtained results.

- 4.4 The argument of the Opponent that it is obvious to the person skilled in the art to construct a tunnel boring machine in such a manner that the breakout force needed is obtained even at the outer periphery of the cutting area of the bucket, has, according to the Board, no link with the problem of obtaining a uniform breakout force throughout the whole cutting area.

By obtaining a more uniform breakout force, as well as an increased breakout force at the outer periphery relative to the normally greater force at the centre, it becomes possible to use smaller boom actuating means when compared to known machines having the same breakout force at the outer periphery.

5. The objection of the Opponent that Claim 1 does not contain enough information for carrying out the invention cannot be accepted by the Board.

This is because Article 100(b) EPC requires that the European patent in total and not an independent claim (e.g. Claim 1 in isolation) should disclose the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art. The present patent, particularly the specific embodiments according to Figures 1 to 3, is in this respect sufficiently clear and complete.

An independent claim should only state the essential features of an invention (cf. Rule 29(3) EPC), but not prescribe down to the smaller detail to the person skilled in the art what he should do to find the most suitable solution. Such a detail would be the feature that the boom is "L"-shaped, which is, however, according to the description of the patent in suit (cf. column 2, lines 11 to 13) only a particular embodiment of the invention.

6. Novelty

None of the available documents discloses the specific subject-matter as set out in Claim 1. Since the Opponent did not dispute novelty, it is unnecessary to give reasons in detail. Therefore, said subject-matter is considered to be new within the meaning of Article 54 EPC.

7. Inventive step

On the question of whether or not the state of the art present in the file could suggest the subject-matter according to Claim 1, the following is to be observed:

7.1 Documents D1 and D2

7.1.1 Document D1 concerns a tunnel boring machine (1) of the type which includes a hollow cylindrical body (25) having a front circular cutting edge and a central longitudinal axis. An excavator (13) is mounted at the front end of the machine within the hollow cylindrical body. A conveyor (27) is mounted within the hollow cylindrical body with a loading end thereof situated adjacent the bottom portion of the circular cutting edge of the excavator. The excavator is operable to cut through material at the front of the machine and to move it onto the conveyor.

The excavator assembly comprises (cf. Figures 1 to 3):

- a carriage (5) for movement along the central longitudinal axis;
- a frame (18) for rotational movement about a vertical axis with respect to the carriage;
- a hollow cylindrical boom (4) mounted on said frame for movements relative to the frame;

- a mounting ring (11) for the rotational movement of said boom, which is telescopically guided in the mounting ring;
- a piston-cylinder assembly (15,17) partly disposed within said boom at its rearward end for the longitudinal movement of said boom;
- a piston-cylinder assembly (21) for the movement of said boom about a horizontal axis of a pivot connected to said frame;
- a bucket (3,13) pivotally connected to said boom, and
- a piston-cylinder assembly (14) pivotally connected inside said boom for the movement of said bucket.

The purpose of integrating the piston-cylinder assemblies for moving the hollow cylindrical boom and the bucket in a tandem arrangement within said boom is to provide a machine for digging tunnels having small diameters (cf. column 2, lines 43 to 47 and 62 to 68).

7.1.2 According to document D2, which concerns a further development of the excavator assembly as disclosed by document D1, the aforementioned piston-cylinder assemblies in the hollow cylindrical boom are disposed in a special tubular frame which is mounted inside said boom and unslidably connected to said boom. The tubular frame and the piston-cylinder assemblies can be mounted into said boom or removed from said boom as one unit. This enables the known tunnel boring machine to be adapted quickly and without problems to local conditions (cf. column 2, lines 23 to 62).

7.1.3 From the combined teaching of the two documents D1 and D2 the person skilled in the art learns to avoid the problems connected with the tight space in tunnels having small diameters by integrating the boom and bucket actuating

means of a tunnel boring machine as an exchangeable unit within a hollow cylindrical boom. However these documents do not contain any reference to the breakout force at the cutting edge of the bucket, let alone to a more uniform breakout force or to an increased breakout force at the outer periphery of the bucket cutting area.

- 7.1.4 Since the hollow cylindrical boom is not pivotally connected to the mounting ring but telescopically guided in the mounting ring, the piston-cylinder assembly for actuating said boom has no effect on the breakout force at the cutting edge of the bucket.

Furthermore, during the longitudinal movement of said boom the position of the pivotal connection of the rearward end of the bucket actuating means to said boom varies relative to the mounting ring from a position substantially behind the mounting ring to a position nearer to the mounting ring.

The tunnel boring machine according to either document D1 or D2, therefore, represents a type of tunnel boring machine which is different from the machine as defined in Claim 1.

Consequently, no hint can be derived from these documents to locate the rearward end of the boom actuating means of an "articulated boom-dipper-bucket assembly" to a rearward point behind the mounting ring to which the boom is indirectly and pivotally connected according to the teaching of Claim 1 of the patent in suit.

7.2 Document D3

The tunnel boring machine known from this document represents a constructional conception which is also different from that of the machine according to the patent in suit. Instead of a boom-dipper-bucket assembly, arms (18) having the form of a bent lever with cutting tools at one end of each lever are pivotally connected to a mounting ring (1). Furthermore, the piston-cylinder assemblies (22,23) for moving the levers extending through the mounting ring are not pivotally connected with their rearward ends substantially behind the mounting ring but with the central part of each cylinder directly to the rear part of said mounting ring (cf. Figures 1 to 4).

The problems concerning the forces which have to be provided by the actuating means, as well as the cutting forces at the cutting edges of the tools are not mentioned in document D3.

Therefore, also this prior art cannot give any suggestion to solve the problem of increasing the breakout force at the outer periphery of the cutting area of the bucket of an articulated boom-dipper-bucket assembly.

7.3 Document D4

This document discloses a tunnel boring machine which has a boom (18) carrying a cutting head (24,25). The rearward end of the boom is pivotally connected to a tubular support (16,17) which is disposed in a rotatable housing (15). The rotatable housing extends through a mounting ring (14) for rotating the housing together with the tubular support. The boom actuating means (20,21) is disposed in the tubular support and pivotally connected to said support substantially behind the mounting ring (cf. column 3, lines 18 to 38; claims 1 to 6; Figure 3).

The constructional conception of the boom actuating means for moving the outer end of the boom toward and away from the central longitudinal axis and the means for rotating the boom about the central longitudinal axis corresponds to the constructional conception of the actuating and rotating means of the articulated boom-dipper-bucket assembly as specified in claim 1. However, as the Proprietor has satisfactorily shown (cf. EP-B-0 024 445, column 6, line 59 to column 7, line 20; Figure 4), the combination of the known constructional conception with only a boom results in a breakout force at the cutting edge of the cutting means which is - firstly, considerably smaller throughout the cutting area (cf. line 66) than the breakout force supplied by an articulated boom-dipper-bucket assembly (cf. document D9) having the boom actuating means mounted on an ear projecting from the mounting ring (cf. line 63), and - secondly, smaller than that supplied by the articulated boom-dipper-bucket assembly according to Claim 1 (cf. line 65).

The Opponent has failed to provide any evidence that the graph (Fig. 4) comparing the breakout force of various types of excavator assemblies is wrong or a tunnel boring machine as disclosed by document D4 is also equipped with an articulated boom-dipper-bucket assembly. Therefore, the teaching of this document cannot support the Opponent's submission that the subject-matter is obvious to the person skilled in the art.

Furthermore, this submission has to be regarded as an ex post facto analysis because the proper question to be asked is not whether a person skilled in the art could have applied the known constructional conception but whether he would have done so in expectation of some improvement of the breakout force at the cutting edge of

the bucket of an articulated boom-dipper-bucket assembly (cf. T 2/83, OJ EPO 1984, 265, Section 7).

In view of the fact, however, that in document D4 no reference is made to the cutting forces of the cutting head supplied by the boom actuating means, the person skilled in the art does not receive any suggestion from said document to consider the content of this document in order to solve the technical problem to be solved (above section 4) in the present case.

7.4 Document D7

The machine for digging tunnels according to document D7 comprises:

- a beam (7);
- a frame (6) pivotally connected to said beam, and
- a shovel (1) pivotally connected to said frame and consisting of two members (2,3) pivotally connected to each other.

The beam is mounted to a cylindrical shield and can be moved parallel to or rotated about the central longitudinal axis of said shield. The frame is actuated relatively to the beam by a piston-cylinder assembly (10) pivotally connected to the rearward end of the beam and to the frame. Further piston-cylinder assemblies (13,17) are pivotally connected to the frame and the shovel to drive its members about corresponding pivot axes at the frame and shovel.

According to Figures 2 to 4, which show the machine in different operating positions, from digging the material at the cutting face to emptying it into a bucket, the position of the frame actuating means and also of the

frame remains unchanged relative to the beam during the whole working cycle. The only purpose of said actuating means is to move the frame from its inoperative position to the operative position (cf. column 3, line 21 to 26). From this it is clear that the frame actuating means do not have any effect on the force at the cutting edge of the outer shovel member. The force at said cutting edge is solely provided by the piston-cylinder assembly (17), which is pivotally connected with its rearward end to the inner shovel member and with its forward end to the outer shovel member (cf. column 3, lines 48 to 61; Figures 2 and 3) by moving the outer shovel member relative to the inner shovel member.

It is the object of the machine known from document D7 to provide a machine which has a very simple construction and which can be utilised for digging tunnels of different diameters in different grounds and for installing the tunnel liner as well (cf. column 1, lines 50 to 65).

Document D7, therefore, illustrates also another type of tunnel boring machine, whose constructional conception is different from that of the machine as specified in claim 1. Furthermore no single suggestion with respect to uniform breakout forces or even to breakout forces in general is given in document D7, so that a person skilled in the art, searching to improve the known tunnel boring machine in this respect, cannot be guided by the content of document D7 to solve the indicated problem (cf. above section 4).

7.5 Consequently, there is no hint in the prior art as disclosed by the above documents which could have a decisive effect on the inventive step of the subject-matter considered.

- 7.6 The other available documents give likewise no hint to the subject-matter of Claim 1. Their teachings could not either alone or in combination with the teachings of the documents discussed in the foregoing sections, lead the person skilled in the art to a machine according to said claim.
- 7.7 Thus, the subject-matter as set forth in Claim 1 involves an inventive step within the meaning of Article 56 EPC.
8. The subject-matter of Claim 1 is, therefore, patentable within the meaning of Article 52 EPC. Claims 2 and 3 concern particular embodiments of the subject-matter of Claim 1 and thus are not open to objection.
9. Rule 29(1) EPC stipulates that claims should wherever appropriate be formulated in two parts. In the present case, the Board considers a two-part claim is not appropriate since the only relevant prior art is the European patent application No. 79 103 162.2 (document D9) (cf. above section 3) falling within the terms of Article 54(3) EPC (cf. also Guidelines for Examination in the EPO, C-III, 2.3a). This prior art is clearly acknowledged in the description (column 1, lines 1 to 19) of the present European patent, as well as in above section 3.

Order

For these reasons, it is decided that:

1. The contested decision is set aside.

2. The case is remitted to the first instance with the order to maintain the patent with the documents filed during the oral proceedings.

The Registrar:



N. Maslin

The Chairman:


C. Andries

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