



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) EP 0 791 690 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:  
27.08.1997 Bulletin 1997/35

(51) Int. Cl.<sup>6</sup>: E02D 17/13, E02F 3/26

(21) Application number: 97102378.3

(22) Date of filing: 14.02.1997

(84) Designated Contracting States:  
DE ES FR GB IT

(72) Inventor: Galdini Villa, Filippo  
48014 Castel Bolognese RA (IT)

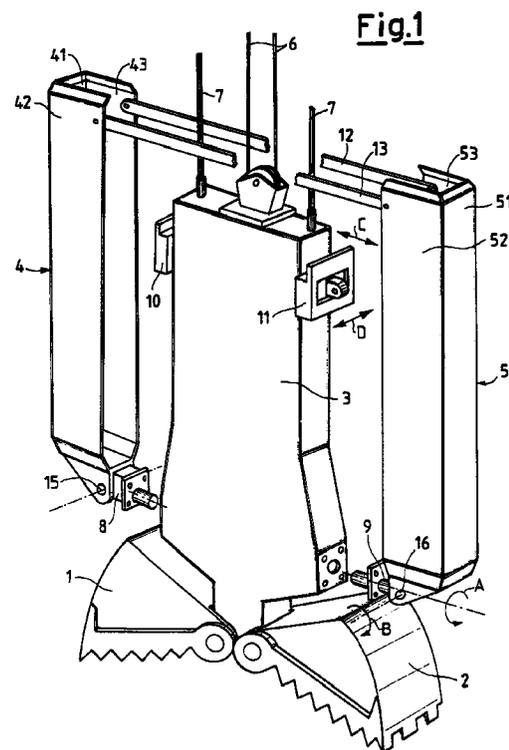
(30) Priority: 26.02.1996 IT TO960125

(74) Representative: Di Francesco, Gianni et al  
Ing. Barzanò & Zanardo Milano S.p.A.  
Corso Vittorio Emanuele II, 61  
10128 Torino (IT)

(71) Applicant: SOILMEC S.p.A.  
47023 Cesena, Forli (IT)

(54) A device for adjusting inclination of an excavating head for constructing concrete underground walls

(57) In a device for adjusting inclination of an excavating head for constructing concrete underground walls, a plurality of movable surfaces are mounted to the excavating head (3) so as to be selectively urged against the walls of the excavation. Said surfaces are comprised of a pair of rigid, substantially vertical guides (4, 5) mounted on two opposite vertical sides of the excavating head. The guides have bottom portions linked (8, 9, 15, 16) so as to accomplish rotation in a respective vertical plane by means of upper actuators (10, 11).



EP 0 791 690 A1

## Description

### Field of the invention

The present invention falls within the field of excavations for constructing concrete underground walls. More particularly, the invention relates to a device for adjusting inclination of an excavating head for said constructions.

### Background of the invention

There are known underground walls composed of a series of adjacent panels. Each panel is constructed in an excavation generally of rectangular cross section elongated in the direction of the curtain. The short sides of the rectangular cross section are located adjacent the short sides of the near panels. Excavation is performed by a grab bucket or a drilling bucket with two, four or more toothed rotary boring tools.

For the stability and efficiency of the work it is important that the wall of the underground wall has no break in continuity, i.e. all adjacent panels must contact throughout the whole depth. Therefore, the long sides and short sides of each panel must be vertical. Moreover, helical torsion of a single panel has to be avoided. It is actually possible that some panels, although being contiguous at the top and having vertical axes, form gaps therebetween under a certain depth due to torsion about the vertical axis. Verticality of the panel sides during excavation is so of primary importance.

Verticality errors are caused by irregularities in the soil and rocks lying on the vertical excavation axis, whilst torsion errors are due to the twisting of the rope during rising and falling of the excavating head.

At present, most buckets or other devices for excavating continuous underground walls are provided with guide elements for limiting deviation from the vertical line. Recent kinds of such elements are capable of accomplishing adjusting movements for correcting the inclination of the excavation and are fitted with sensors for detecting the direction and the extent of a verticality error.

WO 94/21864 discloses a device for maintaining the vertical excavation direction of a subterranean curtain. The device comprises an outer guiding body suspended to an excavator by a rope. A hydraulic clamshell is mounted to an orientable body linked within the outer guiding body so as to correct the excavation inclination relative to the plane of the curtain. Inclination detectors are mounted to the outer and/or inner orientable body. The signals from the detectors are transmitted to a control device which, in the event of the deviation of the clamshell body from the predetermined vertical direction, compensates therefor by pivoting the inner body in relation to the guide in the opposite direction to that of the deviation.

JP-A-3-241 118 discloses an excavator of underground continuous walls making use of an automatic

system for correction inclination of the excavation. Twelve movable surfaces are mounted to the excavating head, six at a higher level and six at a lower level. Said surfaces can be singularly urged towards or retracted from the excavation walls perpendicularly thereto for engaging said walls in sliding contact so as to correct the position of the excavating head and eliminate play relative to the excavation walls.

### 10 Summary of the invention

It is an object of the present invention to provide a device for correcting the excavation inclination whereby inclination can be adjusted in the plane of the wall as well as in a vertical plane perpendicular to the plane of the wall and also torsion about the vertical line can be corrected.

It is another object of the present invention to provide a device of simple construction capable of performing all the adjustments required through a reduced number of controls, thereby being easier to direct.

In accordance with one aspect of the invention as claimed, these objects are accomplished by the provision of a device for adjusting inclination of an excavating head for constructing concrete underground walls, of the type comprising a plurality of movable surfaces mounted to the excavating head and capable of being selectively urged against the walls of the excavation. The device is characterised in that said surfaces are comprised of a pair of rigid, substantially vertical guide means mounted on two opposite vertical sides of the excavating head. The guide means have bottom portions linked so as to accomplish rotation in a respective vertical plane by means of upper actuator means.

### Brief description of the drawings

In order that the present invention may be well understood there will now be described a preferred embodiment thereof, given by way of example, reference being made to the accompanying drawings, in which:

FIG. 1 is an exploded perspective view schematically showing an embodiment of the device of this invention applied to an excavating bucket; and  
 FIGS. 2, 3 and 4 schematically depict a number of operations which the device of FIG. 1 is capable of carrying out.

### Detailed description of a preferred embodiment

With reference initially to FIG. 1, numeral 3 designates the body of a conventional excavating bucket suspended to a rope 6. The excavating bucket 3 is fitted with lower clamshells 1 and 2, opened and closed via suitable power transmission means schematically des-

ignated at 7. These means may indifferently be mechanical (such as rope means), electric (cables) or hydraulic (conduits).

Although the present example refers to a bucket excavating means, it is understood that the device of this invention is equally applicable to excavating apparatuses of different kind, for example those exploiting drilling means.

In accordance with the present invention, coupled to the excavating bucket is a pair of movable guides 4 and 5 mounted to the vertical sides of the excavating bucket body 3. Guides 4, 5 are movable in both the vertical, longitudinal excavation plane and the vertical plane perpendicular to said excavation plane.

In the preferred embodiment shown in the drawings, the guides 4 and 5 have a C-shaped cross section with the open portions of the section facing the excavating bucket body 3. Each guide has three outer walls: a side wall (41 and 51), and two front opposite walls (42, 43 and 52, 53). Preferably, the guides have a C-shaped cross section wide enough not to interfere with the body 3 of the excavating head as they move relative thereto. As an alternative, the guides may be mounted spaced apart from the body 3 in such manner to avoid any contact with it. The example illustrated in the drawings shows that the distance between the opposite front walls of each guide is greater than the thickness of body 3.

The guides 4 and 5 are secured to the body of the excavating bucket through lower pivotal connections 8 and 9 which allow each respective guide to accomplish rotation (see arrow A, FIG. 1) in either direction of rotation about a horizontal geometrical axis passing through both pivotal connections. Furthermore, each guide is provided with a further lower pivotal connection 15, 16 allowing rotation (arrow B, FIG. 1) about horizontal axes substantially perpendicular to the plane of the continuous underground wall (subterranean curtain) to be constructed. The lower pivotal connections 8, 9 as shown in the drawings may obviously be replaced by equivalent binding means, e.g. ball-and-socket joints (not shown), allowing any combination of the rotations shown by arrows A and B.

The top portion of each guide is secured to actuators 10, 11, respectively, capable of pushing and pulling the guide horizontally, in the plane of the underground wall (as indicated by arrow C, FIG. 1) as well as perpendicularly to said plane (arrow D, FIG. 1). Preferably, actuators 10 and 11 are independent of each other and should be able to operate simultaneously in the same or opposite way, to the extent required for correcting inclination of the excavating head, as will be more apparent hereinafter. Actuators 10 and 11, which may have a mechanical, electric or hydraulic control, may be either connected to the power transmission means controlling the excavating device or independent power transmission means. These may be of different kind (mechanic, electric or hydraulic) from those provided for operating the excavating instrument (bucket, drill, etc.).

Owing to the lower linkage which allows the lateral guides to accomplish single (arrows A and B) or combined rotation in vertical planes under the action of respective actuators, the device according to the present invention allows to carry out all the possible corrections of the inclination. As shown in FIG. 2, to divert the excavation sideways (arrow E) in the plane of the underground wall it is sufficient to extend actuator 10 and withdraw actuator 11 in the same horizontal direction (arrows C). Similarly, as shown in FIG. 3, to divert the excavation frontally (arrow F) in a plane perpendicular to that of the underground wall, both actuators 10, 11 are extended parallel in the same direction as indicated by arrow D. To attain a correction of the torsion (FIG. 4, arrow G) the actuators 10 and 11 have to be activated in parallel and opposite horizontal directions (arrows D1 and D2).

Obviously, the device of this invention provides also for combined corrections of verticality and torsion by suitably controlling rotation of the guides and so attain any possible correction resulting from the combination of two or more of the arrows E, F and G depicted in FIGS. 2 to 4. Advantageously, this is accomplished in accordance with the present invention by the provision of only two side guiding means.

Still referring to FIG. 1, the upper end portions of guides 4 and 5 may be mutually connected by horizontal rods 12 and 13 secured so as to allow rotation and torsion shown in FIGS. 2 to 4.

Alternatively, the guides 4 and 5 may have different shapes from the C one described and illustrated, as far as they have walls adapted to engage the walls of the excavation sideways and/or frontally in order to effect the required deviation.

The excavating bucket (or drill or other excavating means used) is fitted with sensors (not shown for simplicity) for detecting all data concerning position and inclination of the excavation at the point of the excavating head. These sensors are connected to an on-surface electronic processing unit for controlling correction of inclination and/or torsion in response to errors being possibly detected. The correction may be performed automatically or manually by an operator.

The sensors can be mounted on the body 3 of the excavating head and/or the movable guides. Said sensors comprise: two inclination detectors, one for sensing inclination in the vertical plane of the underground wall and the other for detecting inclination in the vertical plane perpendicular to said plane of the underground wall; a gyroscope for orientation about the excavation axis; and a depth detector for measuring depth. A sum of increments calculation method allows to know the position of the excavating tool at any depth during the falling step, and particularly the final position relative to the ideal position.

The extent of the distance between the excavating bucket and the walls of the excavation may be gauged by an ultrasonic system of known kind (not shown). The overall available data (concerning distance from the

walls of the excavation, depth, inclination) provide continuous information which enables to know the instantaneous shape of the excavation and modify it if necessary.

The comparison between the ideal shape of the excavation provides the correction to be made to reduce and nullify any error. Correction can be carried out automatically or by an operator.

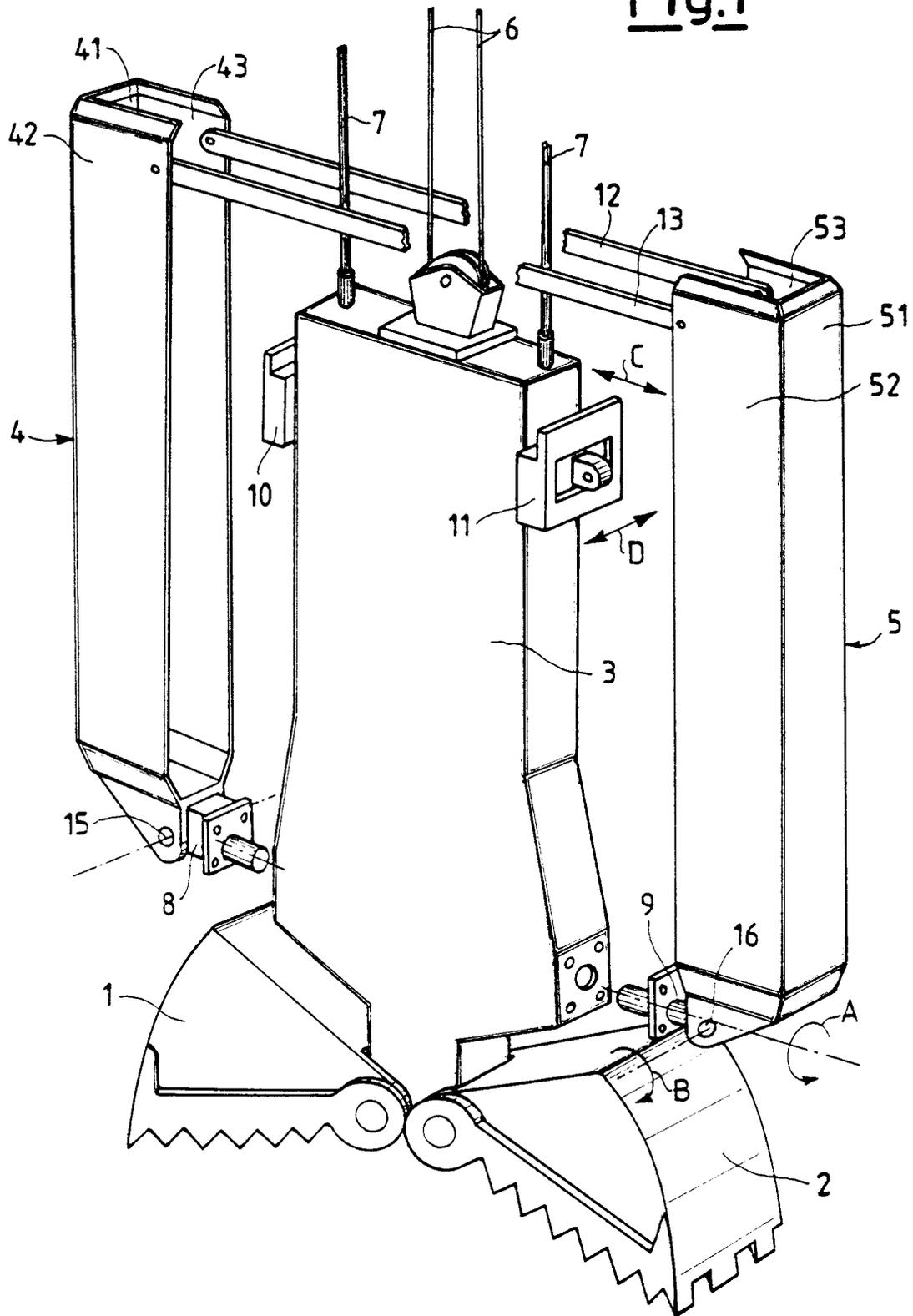
The disclosures in Italian patent application No. TO96A000125 from which this application claims priority, and in the abstract accompanying this application are incorporated herein by reference.

## Claims

1. A device for adjusting inclination of an excavating head for constructing concrete underground walls, of the type comprising a plurality of movable surfaces mounted to the excavating head (3) and capable of being selectively urged against the walls of the excavation, characterised in that said surfaces are comprised of a pair of rigid, substantially vertical guide means (4, 5) mounted on two opposite vertical sides of the excavating head, said guide means (4, 5) having bottom portions linked (8, 9, 15, 16) so as to accomplish rotation in a respective vertical plane by means of upper actuator means (10, 11).
2. A device as claimed in claim 1, characterised in that each of said actuator means (10, 11) is capable of acting along perpendicular directions (C, D) in a substantially horizontal plane.
3. A device as claimed in claim 1, characterised in that said actuator means (10, 11) are independent.
4. A device as claimed in claim 1, characterised in that each guide means (4, 5) is linked by two lower pivotal connections (8, 15; 9, 16) about horizontal axes perpendicular therebetween.
5. A device as claimed in claim 1, characterised in that said guide means (4, 5) have a C-shaped cross section with the open portions of the section facing the body (3) of the excavating head.
6. A device as claimed in claim 5, characterised in that the C-shaped cross section of said guide means (4, 5) is wide enough not to interfere with said body (3) of the excavating head while moving with respect thereto.
7. A device as claimed in any of the preceding claims, characterised by being provided with inclination sensor means, depth sensor means, and means for sensing the orientation of the excavating head.
8. A device as claimed in any of the preceding claims,

characterised by comprising means for detecting the distance between the excavating head and the walls of the excavation.

**Fig.1**



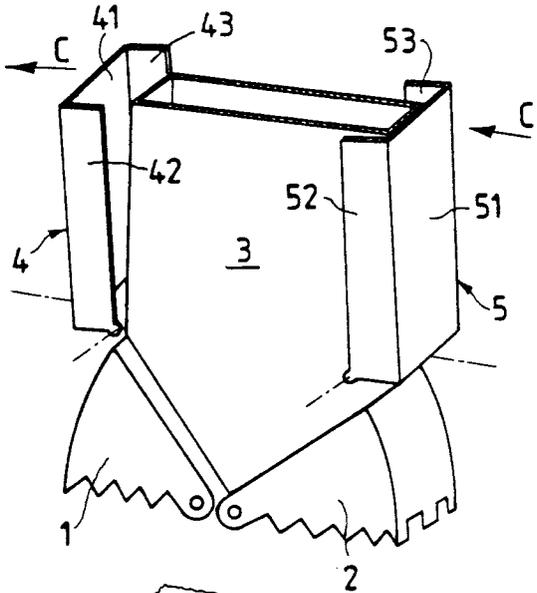


Fig.2

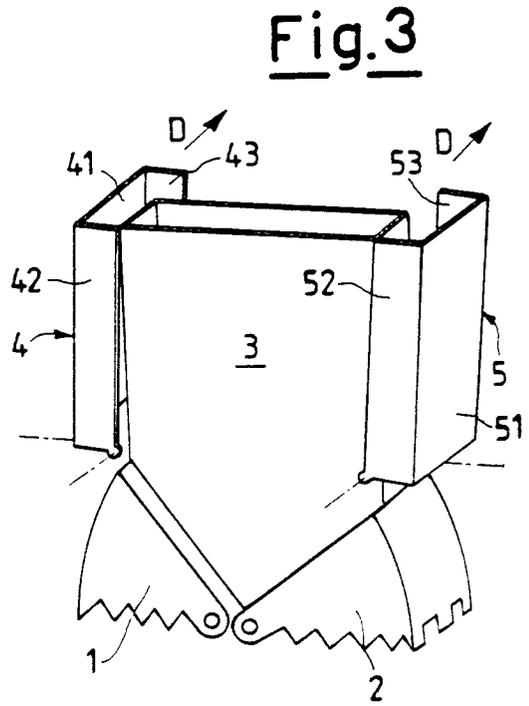


Fig.3

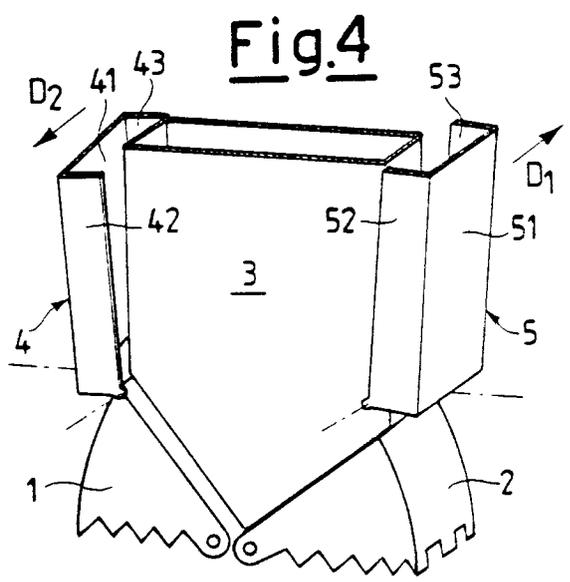


Fig.4



European Patent  
Office

EUROPEAN SEARCH REPORT

Application Number  
EP 97 10 2378

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 518 298 A (BAUER SPEZIALTIEFBAU) 16 December 1992	1-4	E02D17/13 E02F3/26
Y	* the whole document *	5,6	
A		7,8	
	---		
Y	US 4 718 504 A (TERASHIMA TUTOMU ET AL) 12 January 1988	5,6	
A	* column 3, line 16 - column 6, line 13; figures 1-6 *	1-4,7,8	
	---		
A,D	PATENT ABSTRACTS OF JAPAN vol. 016, no. 030 (M-1203), 24 January 1992 & JP 03 241118 A (FUJITA CORP), 28 October 1991, * abstract *	1-8	
	---		
A	DE 38 05 868 A (HOCHTIEF AG HOCH TIEFBAUTEN) 7 September 1989 * column 2, line 39 - column 3, line 51; figures 1-6 *	1-6	
	-----		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E02D E02F
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		16 June 1997	Tellefsen, J
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)