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(54) **MULTI-SHAFT EXCAVATING DEVICE**

MEHRARMIGE AUSSCHACHTUNGSVORRICHTUNG

DISPOSITIF D'EXCAVATION A ARBRES MULTIPLES

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JP-B- 4 048 891 **JP-U- 5 054 637**

• **PATENT ABSTRACTS OF JAPAN vol. 007 no.**
203 (M-241), 8 September 1983 & JP-A-58 101930
(TOSHIO ENOKI; OTHERS: 01) 17 June 1983,

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Description

[0001] The present invention relates to a multi-shaft drilling apparatus having three rotatable auger shafts, for use in forming a continuous wall under the ground.

[0002] A soil mixing process has been widely used for forming such a wall. In a known soil mixing process, subsoil is drilled in a wall shape and a mixed liquid containing cement or the like is supplied from an end of an auger shaft to mix with the in-situ soil to develop a continuous wall, which can be a cut-off wall or a retaining wall or shoring in underground works of civil engineering.

[0003] A known multi-shaft auger machine for forming such a continuous wall will first be described with reference to Figs. 5 and 6 of the accompanying drawings.

[0004] In this machine a drive unit 3 is mounted to move vertically on a guide post 2 mounted on a crawler truck 1, a multi-shaft drilling apparatus 4 is connected to the lower part of said drive unit 3, and a plurality of auger shafts (three in this embodiment) 5A, 5B and 5C are provided in said multi-shaft apparatus 4.

[0005] A drilling cutter 6 is mounted at the lower end of each auger shaft nothing 5. Screw type blades 7, whose diameter is the same as the drilling cutters 6, and bar-shaped auger blades 8 are alternately located above each drilling cutter 6. The auger blades cooperate reciprocally to form a continuous wall unit by mixing the in-situ soil with mixed liquid as aforesaid. If necessary, water retention and sealing ability may be improved by molding H-type steels or sheet piles to the said continuous wall.

[0006] In this multi-shaft auger machine of the prior art, triangular irregularities are generated between the overlapping paths of rotation of the drilling cutters, longitudinally on both sides of the continuous wall unit formed by the auger shafts, which are not desirable as regards the strength of the wall. Therefore, the present applicant proposed a new apparatus for forming a straight-sided continuous wall unit, in Japanese Patent Application Publication No. 2-115406. In such apparatus, chain driven drilling cutters are provided close to the lower ends of the auger shafts. This is quite effective, but there is a problem of reliability because the machine is chain driven and the chains are apt to loosen or be damaged.

[0007] JP-U-5-054637 and JP-A-5-179649 disclose other examples of multi-shaft drilling units for forming a continuous wall under the ground.

[0008] Thus an object of the present invention is to provide an improved multi-shaft drilling apparatus for forming a continuous wall in a straight line.

[0009] According to the invention there is provided a multi-shaft drilling apparatus having three auger shafts, for forming a continuous wall under the ground, said apparatus including a housing arranged to maintain the pitch between said auger shafts, said housing incorporating:

first drive transfer means rotatable around the central one of said auger shafts;

a pair of second drive transfer means engaging with said first transfer means;

third drive transfer means integral with said second drive transfer means;

fourth drive transfer means engaging with said third drive transfer means and being fixed to a rotary shaft which crosses at right angles a straight line connecting the center of said auger shafts; and

cone-shaped cutters fixed on both end of said rotary shaft, the cutter diameters increasing in the direction away from the said straight line.

[0010] In a preferred form of the invention, gears are used as the said first and second drive transfer means, and bevel gears are used as the third and fourth drive transfer means.

[0011] The said cone-shaped cutters are formed as circular cones and as truncated cones.

[0012] A guide shaft is preferably provided at one end of the drilling unit, the said drilling shafts being arranged in a line. Such a guide shaft can be provided at both ends of the unit. A jet nozzle is preferably provided on the or each said guide shaft, said nozzle preferably being on a tangent line to the outside of the guide shaft.

[0013] The or each guide shaft is preferably provided with a tubular guide bit formed with a concavity which partially embraces a bit of the adjacent drilling shaft.

[0014] A multi-shaft drilling apparatus constructed as above enables a triangular region of soil, which has conventionally remained, to be completely cut off by the said cutters, whereby a continuous wall unit with semicircular ends and straight sides can be formed.

[0015] Since the said cutters are cone-shaped, i.e. truncated cone-shaped, soil of an almost triangular section can be displaced, which has not been possible previously. Any remaining soil will collapse naturally by gravity, vibration or other means, even if the pitch between the auger shafts is made longer. Thus the pitch between the auger shafts can be increased by the use of the present invention, which can reduce the time and labor involved in forming a continuous wall.

[0016] When a guide shaft is provided at one end of a line of auger shafts centers, a guide hole is drilled first which receives the guide shaft while holes are being drilled by the auger shafts. As a result, a number of successive holes can be drilled with good linearity, since the guide shaft receives the reaction force. Additionally, since a hole at the end of a series can be used as a guide hole when a first drilling operation is completed, continuity to a second drilling operation can be achieved. Also, if the unit is provided with jet nozzles as aforesaid, a cross section of subsoil can be drilled in a

wall shape and a drilling blade can be washed.

[0017] An embodiment of the present invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic front view of a relevant part of an embodiment of the invention.

Fig. 2 is a side view of Fig. 1.

Fig. 3 is a horizontal section view showing further details.

Fig. 4 is a section view on the line A-B-C-E of Fig. 3.

Fig. 5 is a side view of a known unit.

Fig. 6 is a front view of an auger shaft of the machine of Fig. 5.

[0018] In Figs. 1 and 2, the pitch between the auger shafts 5A, 5B and 5C is maintained by the housing 11 of a cutter drive unit 10 provided with bearings. Two pairs of cutters 22, described below, are provided on the unit 10 with their planes parallel to a straight line L connecting the centers of the auger shafts 5.

[0019] As seen in Figs. 3 and 4, the housing 1 of the cutter drive unit 10 is formed in an H-shape by a primary part 12 located on the center line L and two secondary parts 13 which cross the center line L orthogonally between the shafts 5.

[0020] A primary gear 14 (the first transfer means) is connected to the auger shaft 5B by serrations. The primary gear is engaged with a pair of secondary gears 15 (the second transfer means) which are arranged on the center line L in the primary part 12. Each secondary gear 15 is keyed to a shaft 17 which extends vertically and carries on its upper portion a primary bevel gear 18 (the third transfer means) projecting into the secondary part 13. A rotary shaft 19 is located in the secondary part 13 by three pairs of bearings 20. A secondary bevel gear 21 (the fourth transfer means) engaging with the primary bevel gear 18 is keyed to the shaft 19 on one side of two of the bearings 20, and a cutter 22 is fixed on each end of the shaft 19. Each cutter 22 is of truncated conical shape, expanding outwardly, so as to cut an outer triangular convex area A which is generated on both sides of the center line L by the outer rotation loci D of the drilling cutters 6 (Fig. 6) which overlap alternately.

[0021] Consequently, when the auger shafts 5 rotate in the directions of the arrows in Fig. 1 during drilling, due to the interaction of the four transfer means, the pairs of cutters 22 will rotate in opposite directions as shown by the arrows, to cut the outer part A. As a result, an area of subsoil S (Fig. 3), of which the ends form semicircles and the sides form straight lines, is drilled by the three outer rotation loci D and the outer surfaces of the four cutters, to form a continuous wall U. Since the cutters rotate in opposite directions, the rotary reaction force is relieved and good balance is achieved. Although parts A1 are not cut, these parts are very small and thus negligible. Also, the outer auger shafts 5A and 5C can be moved on the center line L as indicated by arrow E

to minimise the other uncut parts A2.

[0022] Since the cutters are of truncated conical shape, almost all of part A can be drilled and any remaining part which the cutters do not reach will readily collapse under gravity, vibration or by other means, even if the pitch between the auger shafts is made greater. Therefore, the time, labor and the other costs involved in forming a continuous wall unit can be reduced by lengthening the pitch between the auger shafts.

[0023] Some advantageous effects of the present invention, at least in its preferred forms, are as follows:

(1) A wall shaped continuous wall can be formed.

(2) Since the cutter reaction force is relieved, the balance is good.

(3) Various costs in forming a continuous wall may be decreased by lengthening the pitch between the auger shafts.

(4) The drilling range can be expanded by moving the auger shafts on both sides slightly outwards.

(5) The reliability is much higher as compared with a chain drive, since a gear drive can be employed.

Claims

1. A multi-shaft drilling apparatus having three auger shafts (5), for forming a continuous wall under the ground, said apparatus including a housing (11) arranged to maintain the pitch between said auger shafts, said housing incorporating:

first drive transfer means (14) rotatable around the central one of said auger shafts;

a pair of second drive transfer means (15,17) engaging with said first transfer means;

third drive transfer means (18) integral with said second drive transfer means (17) ;

fourth drive transfer means (21) engaging with said third drive transfer means and being fixed to a rotary shaft (19) which crosses at right angles a straight line (L) connecting the center of said auger shafts; and

cone-shaped cutters (22) fixed on both end of said rotary shaft, the cutter diameters increasing in the direction away from the said straight line (L).

Patentansprüche

1. Mehrwellige Bohrvorrichtung mit drei Bohrerwellen (5) zum Bilden einer durchgehenden Abbaustrecke unter Grund, wobei die Vorrichtung ein Gehäuse (11) aufweist, das dazu ausgelegt ist, den Abstand zwischen den Bohrerwellen aufrechtzuerhalten, wobei das Gehäuse folgendes aufweist:
- ein erstes Antriebsübertragungsmittel (14), das um die zentrale Bohrerwelle der Bohrerwellen drehbar ist, 10
- ein Paar von zweiten Antriebsübertragungsmitteln (15, 17), die in das erste Übertragungsmittel eingreifen, 15
- ein drittes Antriebsübertragungsmittel (18), das einstückig mit dem zweiten Antriebsübertragungsmittel (17) ausgebildet ist, 20
- ein viertes Antriebsübertragungsmittel (21), das in das dritte Antriebsübertragungsmittel eingreift und fest mit einer Drehwelle (19) verbunden ist, die eine die Mittelpunkte der Bohrerwellen verbindende gerade Linie (L) unter rechtem Winkel schneidet, und 25
- konusförmige Bohrer (22), die an beiden Enden der Drehwelle befestigt sind, wobei die Durchmesser der Bohrer von der geraden Linie (L) weg zunehmen. 30

une ligne droite (L) reliant les centres desdits arbres de forage, et

des couteaux coniques (22) fixés aux deux extrémités dudit arbre rotatif, les diamètres des couteaux augmentant dans la direction qui s'écarte de ladite ligne droite (L).

Revendications

1. Appareil de forage multi - arbres, comportant trois arbres de forage (5) pour former une paroi continue sous le niveau du sol, ledit appareil incluant un carter (11) agencé pour maintenir le pas entre les arbres de forage, ce carter comprenant :
- un premier dispositif d'entraînement de transfert (14) rotatif autour de l'arbre central desdits arbres de forage, 45
- une paire de seconds dispositifs d'entraînement de transfert (15, 17) coopérant avec ledit premier dispositif de transfert, 50
- un troisième dispositif d'entraînement de transfert (18) monopièce avec le second transfert d'entraînement (17),
- un quatrième dispositif d'entraînement de transfert (21) coopérant avec ledit troisième dispositif d'entraînement de transfert, et fixé à un arbre rotatif (19) qui coupe à angles droits 55

Fig. 1

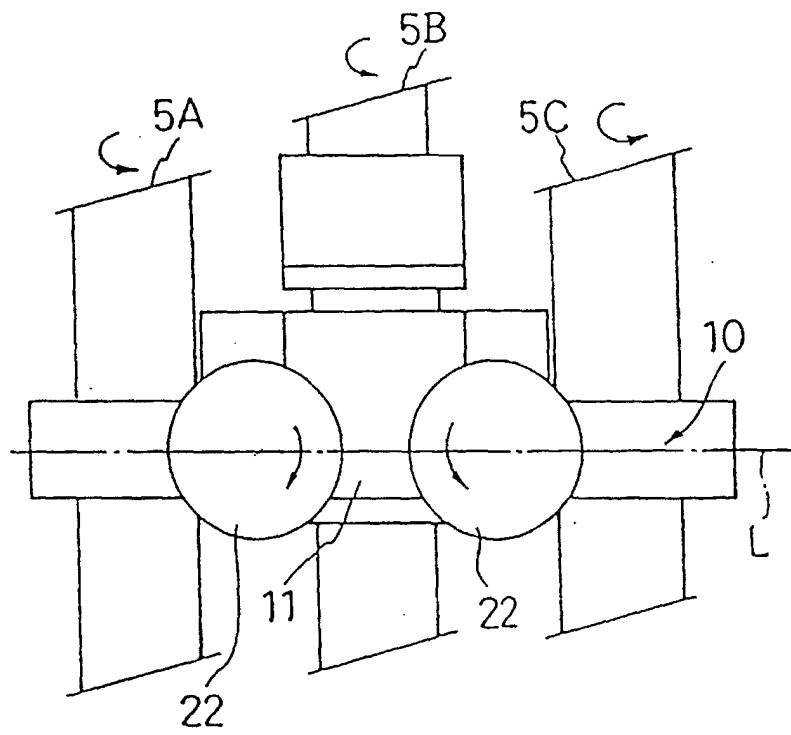


Fig. 2

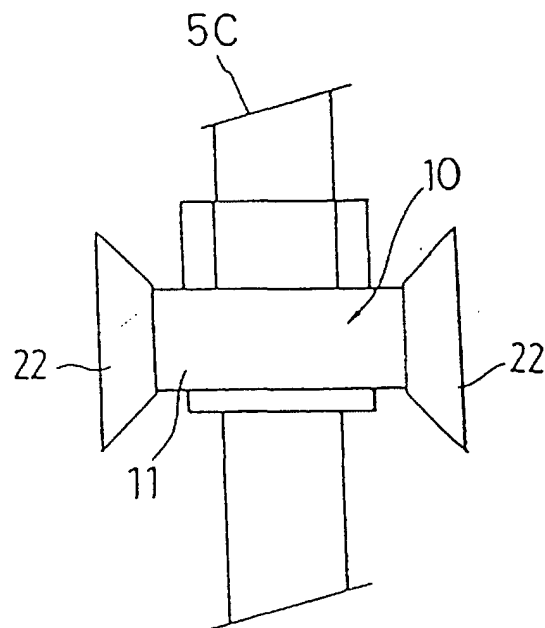


Fig. 3

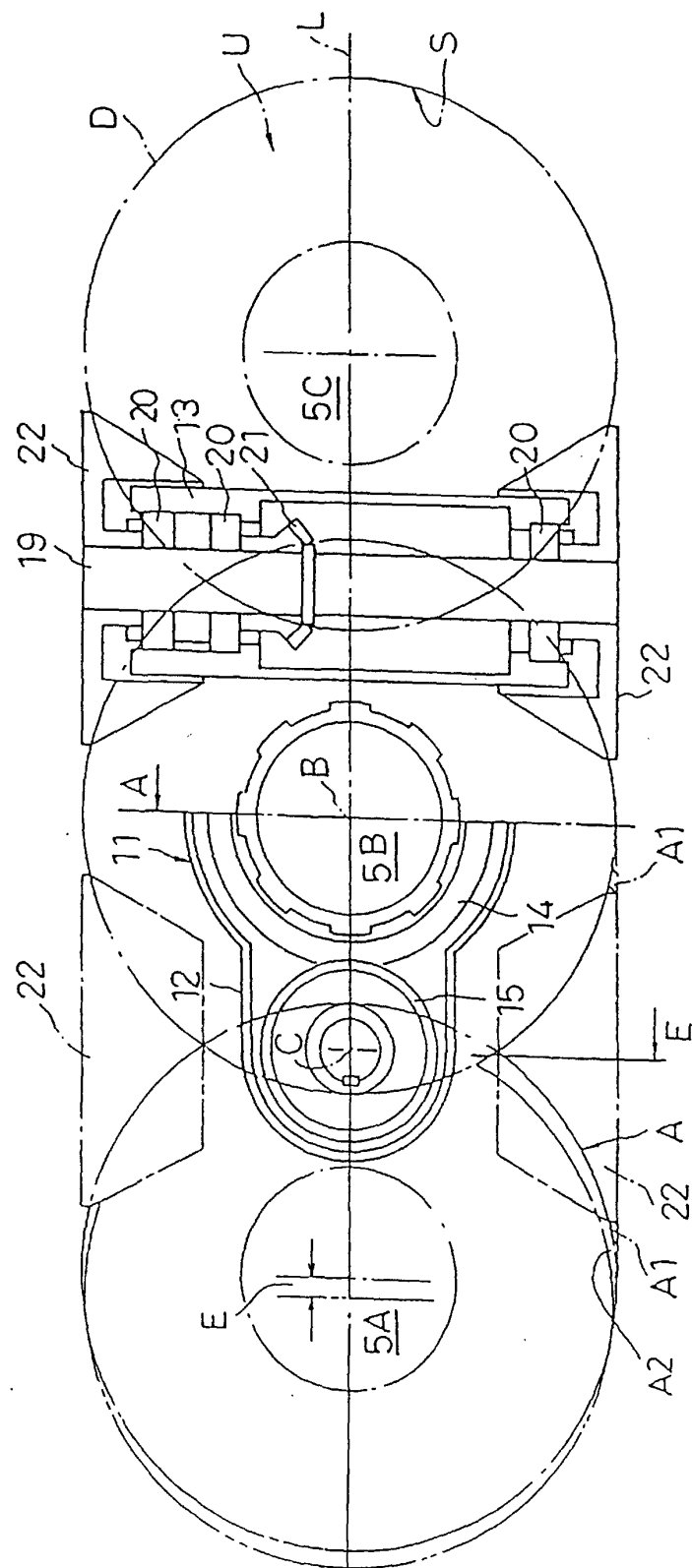


Fig. 4

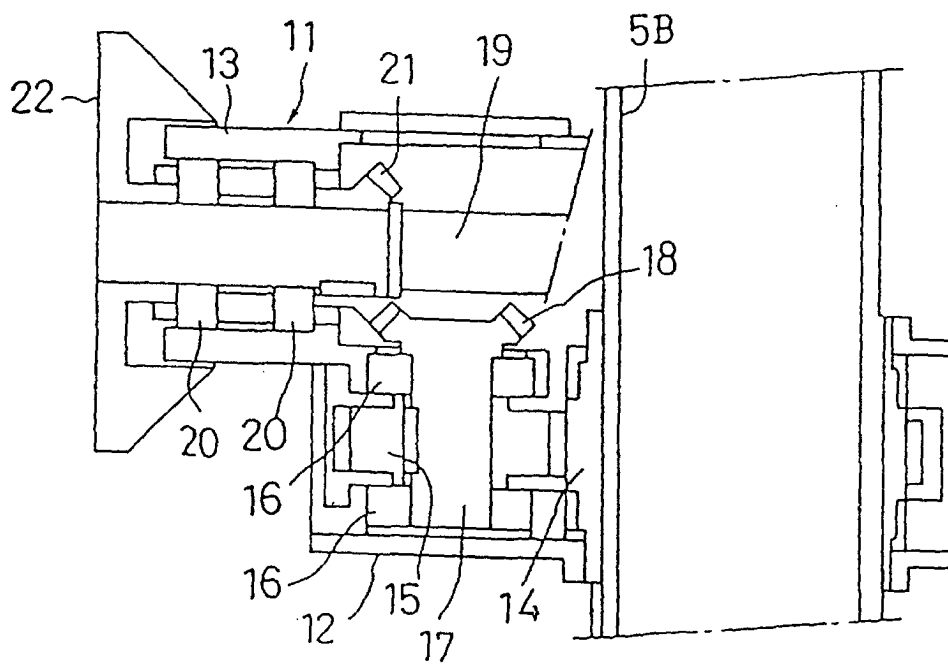


Fig.5

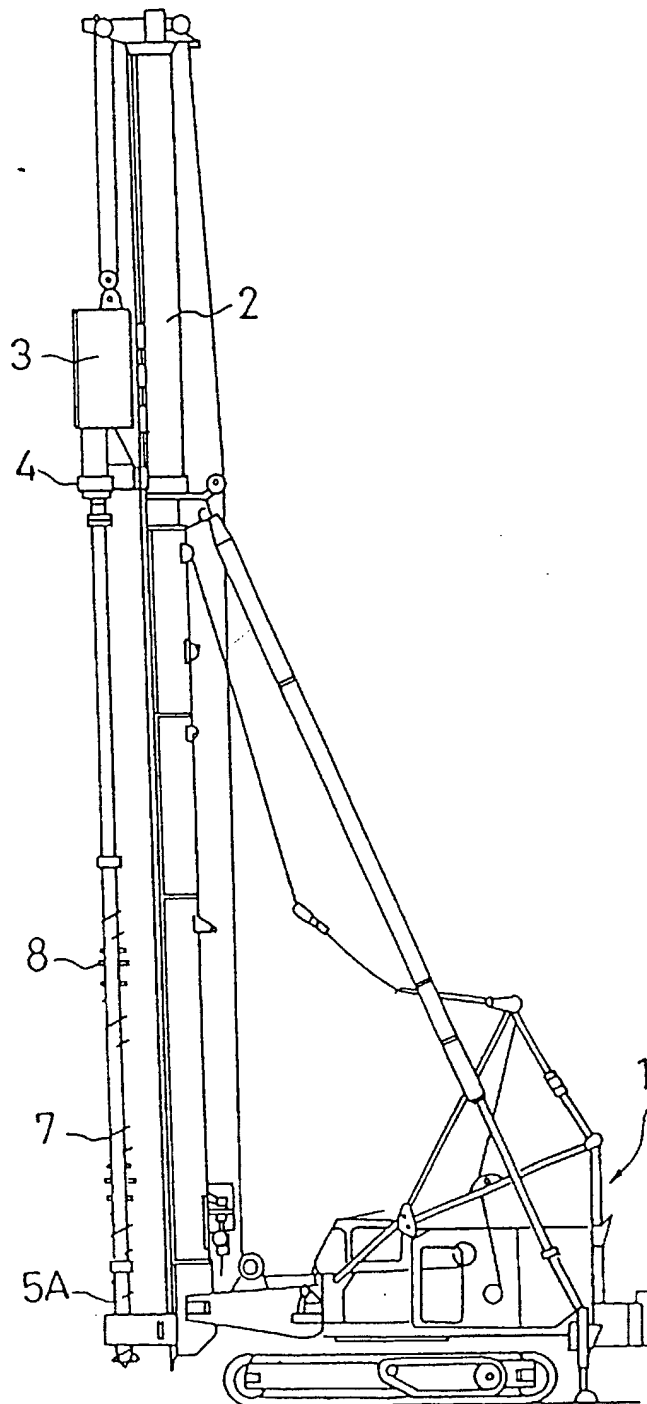


Fig. 6

