Nov. 2, 1965
J. DESVAUX ETAL
3,215,209
DEVICE FOR ACTING ON PILES, TUBING, SHEET-PILING AND THE LIKE
Filed Nov. 20, 1961

Fig. 1

Fig. 2

INVENTORS
JACQUES DESVAUX
FRANÇOIS BERTHE

By: IRWIN S. KHATZ
ATTY.
DEVICE FOR ACTING ON PILES, TUBING, SHEET-PILING AND THE LIKE

Jacques Devaux, 17 Ave. du Colonel Bonnet, Paris, France, and François Berthet, 16 Rue Voltaire, Houlles, France

Filed Nov. 20, 1961, Ser. No. 153,504

Claims priority, application France, Dec. 9, 1960, 846,425

1 Claim. (Cl. 173—49)

The present invention relates to the driving and extraction of piles, sheet-piling, tubing, and the like, and more especially to the technique known as "self-driving," which consists in effecting the driving or extraction by means of an impulse device mounted directly on the pile or the like, without external support.

In the U.S. Patents Nos. 2,942,427 and 3,008,528, there has been described a driving device of the kind referred to, in which the impulses obtained by means of an appropriate generator are converted to unidirectional percussions. These percussions are supplied in particular by means of eccentrically-weighted fly-wheels, and more precisely by the vertical or longitudinal component of the centrifugal force of fly-wheels rotating in synchronism, the other components balancing out in the horizontal or transverse direction.

Patent No. 3,008,528 has proposed the addition to the generator of alternating percussions of an elastic means such as a spring for the damping and the recuperation of the upward percussion for driving or the downward percussion for extraction, this spring being placed between the percussion generator and the frame which is rigidly fixed to the pile.

In this way, devices have been constructed which ensure the driving of piles or the like and also their extraction, under good conditions of rapidity and effectiveness.

However, in certain cases for example, if the ground in which the pile is to be driven is or becomes too hard, or alternatively if the ground has too little resistance through the first few meters from the surface, or again in ground having very low lateral friction, it has been observed that the driving device had sometimes a tendency to rise between the percussions of the stage of upward movement of the impulse-generator fly-wheels.

This rising tendency, which results in a slight upward movement of the pile between the working percussions, is undesirable. It eliminates or reduces contact of the point of the pile with the ground at the moment of the following percussion, which adversely affects the effectiveness and the efficiency of this latter percussion.

The present invention has for its object to obviate this disadvantage, while at the same time offering various advantages of application of the driving device.

It consists in providing the pile-driving or extraction device (for piles, sheet-piling, tubing or the like) with means which counteract, reduce or annul the effect of the forces directed in the sense opposite to that of the working percussions. In the case of vertical driving percussions, it is the forces directed vertically upwards which are reduced or annihilated; if the percussions are upward for extraction, it is the downwardly-directed forces which are counteracted. In the case where the percussions are directed obliquely or even horizontally, it is the oblique or horizontal longitudinal forces which are compensated.

A method of counteracting the forces acting in opposition to the percussions consists in providing the driving device with a supplementary elastic member, such as a spring, arranged between the pile or a frame fast with the pile and the impulse generator, in the zone and on the side where the working percussions are produced.

This supplementary elastic member acts in the direction opposite to that of the elastic damping and recuperation device for the upward impulses. It creates a downward action in opposition to the rising tendency. This action maintains contact of the working point of the pile with the ground at the bottom of the hole, and ensures that the percussions have their full effect. This supplementary elastic means has the further advantage of permitting the frequency of the percussions to be increased.

Another means of counteracting the forces acting in opposition to the working percussions consists in generating these percussions by means of several pairs of eccentrically-weighted fly-wheels balanced and synchronized in each pair, the pairs of fly-wheels rotating at different speeds which are multiples of each other. In its most simple form, this means consists in utilizing two pairs of eccentrically-weighted fly-wheels, one of which rotates at twice the speed of the other. In this way, stronger impulses are obtained in one direction than in the other and in consequence, in the case of driving there is a predominance of the downward percussions over the upward forces and vice-versa in the case of extraction.

The two means previously defined can be put into use in combination, since their effects are advantageously additive both for the elimination of the undesirable lifting of the pile and for the increase of the frequency of the percussions and its adaptation to the nature of the ground being driven.

In particular, various arrangements, known or novel, of pairs of fly-wheels rotating at the same or different speeds may be provided. Thus, the pairs of fly-wheels may be disposed in the moving generator of the driving device. It is however also possible, on condition that they are associated by an appropriate transmission, to place them partly on the moving generator and partly on the frame of the device. Or again they may be mounted on separate moving generators which are suitably associated.

According to the invention, the device carrying into effect the foregoing arrangements comprises, as has already been explained, a generator of alternating impulses with the conversion of the impulses to percussions in one direction only.

The means employed for obtaining this conversion ensure, as has already been stated above, the production of a percussion force which is much greater than the force of the alternating impulses themselves before the said conversion.

Under these conditions, and if the motors which produce the alternating impulses are arranged in the generator itself and are rigidly fixed thereto, one of the faces of the generator being used to strike the pile or the frame which is rigidly fixed to it, the said motors are subjected by the percussion to considerable jerks or shocks resulting in particular from the setting-up of high-frequency vibrations at that moment in the pile and in the driving or extraction device which is rigidly fixed to it.

This is especially the case with the generator having eccentrically-weighted fly-wheels driven by hydraulic motors placed on these fly-wheels in the body of the striking mass itself.

These jerks or shocks would be liable to damage these motors very rapidly. In this way, some motors have been put out of service after a few minutes of working of the devices in question.

According to the invention, there is then interposed between the portion of the generator which strikes the pile and that which comprises the motors, a damping device, the characteristics of which, for example the thickness and the deformation in the case of a simple shock-absorber of rubber, are such that there is absorption of the high-frequency and high intensity oscillations or vibrations, without however any counteraction or even re-
duction of the transmission of the forces or blows at relatively-low frequency due to the percussions produced by the impulse generator.

The particular features and other advantages of the invention will be more fully described with reference to the accompanying drawings which show various forms of embodiment, in comparison with the prior arrangement of which they are improvements.

FIG. 1 shows a view in elevation of the known arrangement.

FIG. 2 is a view in elevation of an arrangement in accordance with the invention.

FIG. 3 is an explanatory diagram of FIG. 2. FIG. 4 shows a further form of embodiment of the invention.

FIG. 5 is an explanatory diagram relating to FIG. 4. FIGS. 6 and 7 relate to further forms of embodiment.

FIG. 8 is an explanatory diagram in connection with FIG. 7.

FIG. 9 shows examples of construction of the shock-absorber member which absorbs the parasitic oscillations or vibrations.

FIG. 10 is an explanatory diagram relative to FIG. 9. FIG. 11 shows an alternative form of the shock-absorber.

In FIG. 1, there is shown a driving and extraction device in accordance with Patent No. 3,008,528, arranged for driving sheet-piling. This device comprises a frame 10, the lower portion 11 of which is arranged so as to engage the top of the upper portion of the sheet-piling 12. The pile 12 is gripped in the portion 11 by means of any appropriate clamping device 13, mechanical, pneumatic, hydraulic or other.

The impulse generator 14 is slidable mounted in the interior of the frame 10. This generator is for example arranged with two fly-wheels 15 having eccentric weights 16, rotating in opposite directions and synchronized. This generator is arranged so as to produce percussions which are transmitted by the hammer 17 to an anvil 18 carried by the lower portion 11 of the frame 10 and to the sheet-piling 12.

It should be observed that the assembly of the generator and its frame is mounted on the sheet piling 12 without any external support, the technique known as "self-driving" referred to in Patent No. 2,942,427.

The generator 14 as shown in this case produces alternating impulses. It is preferably arranged so as to convert these impulses into unidirectional percussions, for example following the arrangement described in Patent No. 2,942,427.

In accordance with the provisions of Patent No. 3,008,528, one or a number of elastic elements, for example the springs 19, are interposed between the impulse generator 14 and the upper portion 20 of the frame 10. The tension of the spring or springs is regulated by means of jacks 21, it being possible to carry out this adjustment while working. The spring or springs 19 have the effect of storing the energy developed by the impulse generator 14 during its upward travel and restoring the energy during the downward travel, thus increasing the effect of percussions on the anvil 18 and on the sheet-piling 12. In addition, the spring or springs 19 permit the frequency of the oscillations of the generator 14 to be increased.

It will be recalled that for the extraction of the pile, the actions are reversed. In particular, the hammer 17 and the anvil 18 are then placed above the generator 14, and the springs 19 and 22 are interchanged in position.

A further means, which can be employed with that of the preceding embodiment of FIG. 2, but which can also be applied independently of the previous method, consists in equipping the driving device with an impulse generator comprising a number of sets of fly-wheels synchronized in each set, rotating at different speeds and supplying for the reason differentiated vertical actions, upwards and downwards.

An arrangement of this kind is shown in FIG. 4. The impulse generator 14e movably mounted on frame 10e comprises two sets of superposed fly-wheels 24 and 25. In each set, the fly-wheels are synchronized. One of the
sets of fly-wheels, 24 for example, rotates faster than the other set 25. These fly-wheels carry eccentric weights 26 and 27 respectively, having appropriate masses and positions, in particular being so arranged that they coincide in the bottom positions when the eccentric weights 27 of the slower fly-wheels 25 reach the lower position. The fly-wheels 24 and 25 are associated by an appropriate transmission 36 comprising a rotating shaft having a bevel gear at its ends.

By this means, a more powerful action is obtained in the downward direction than in the upward direction, as explained by the diagram of FIG. 5. In this diagram, it has been assumed that the fly-wheels 24 are rotated twice as fast as the fly-wheels 25. During the course of a cycle of rotation of the slower fly-wheels 25, the assembly passes through successive phases I, II, III, IV, V, the latter phase being identical with phase 1 and recommencing the cycle.

If F is the resultant of the vertical forces due to the fly-wheels 24 and f is the resultant of the vertical forces due to the fly-wheels 25, it can be shown that this resultant reaches F = f in the downward direction, but remains limited to F in the upward direction. By a suitable choice of the masses of the weights 26 and 27, it is an easy matter to obtain f=F. The force is thus doubled in the driving direction without affecting the speed in the upward direction. This results in an improvement of the efficiency of the device.

According to a further form of embodiment shown in FIG. 6, in addition to the generator 14b with its fly-wheels 15b and eccentric weights 16b, the device comprises a second set of fly-wheels 28 with eccentric weights 29, this being mounted on the frame 16b. This second set of fly-wheels 28 is synchronized with the fly-wheels 15b by a conventional sliding or telescopic transmission 30 having bevel gearing at its ends and a splined connection intermediate its length by which the two sections of transmission 30 are enabled to have axial sliding movement relative to each other. However, the directions of rotation of the fly-wheels 28 are reversed with respect to those of the fly-wheels 15b.

When the generator 14b moves upwards after a percussion, it may have a tendency to lift the sheet-piling 13 by compressing the spring 19. The fly-wheels 28 opposite this tendency by pushing the sheet-piling 13 downwards. The two effects annul each other. At the following half period, the fly-wheels 28 will tend to lift the pile at the moment when the percussion of the generator 14b drives it. As the effect of percussion is considerably greater than the effect of the fly-wheels 28, the lifting tendency of the fly-wheels 28 has no effect.

FIG. 7 shows a further arrangement with two sets of fly-wheels rotating in opposite directions. In this arrangement, one of the sets of fly-wheels 15c is carried by the generator 14c as in the previous case. The generator 14c, sliding in the frame 10c, carries itself a frame 31 with slides, on which moves a further impulse generator 12c carrying the fly-wheels 33 with eccentric weights 34. The fly-wheels 33 are synchronized with the fly-wheels 15c by a conventional sliding or telescopic transmission 35 similar to transmission 30 described above.

The fly-wheels 33 and 15c rotate in opposite directions. The springs 19 and 22 of the previous examples are placed in this case on each side of the generator 32.

In this arrangement, the vertical component at every instant opposite to the generator 32 acts against that produced by the generator 14c. Any tendency of the sheet-piling to lift is thus eliminated, since no reaction of the generators is transmitted to it, with the exception of the percussion which takes place during one of the phases of the movement of the said generator 14c.

In another phase of movement of the generator 14c, the latter tends to rise and its upward movement is counteracted by the effect of the generator 32, which has the result of accelerating the movement of the generator 14c downwards. This acceleration depends on the characteristics of the springs. At the moment of the percussion, the generator 32 obviously tends to lift the generator 14c, but this tendency to lift, acting in a direction contrary to driving, has no effect since the force of the percussion blow is from 10 to 12 times greater than that of the centrifugal force developed by the generator 32, and it is the impulses produced by the generator have suitable lengths and frequencies.

This assembly is comparable in a way, with two synchronous pendulums D and E (FIG. 8) coupled together by a spring G. The frequencies of oscillation of this unit depend on the compression gradient of the spring G.

The conditions of operation thus depend on the characteristics of the springs 19 and 22, which should be springs with a variable gradient.

In FIG. 9, there has been shown one of the possible arrangements of the shock-absorber placed, according to the invention, between the motor or motors 37 of the impulse generator and the portion of this generator which strikes the pile or the frame which is rigidly fixed thereto.

For the sake of clearness of the drawings and with the object of simplification, this shock-absorber has been shown applied to a device of the type illustrated in FIG. 1 above; it will however be obvious that it may be utilized with any one of the arrangements previously described.

In FIG. 9 can be seen the shock-absorber 38, which may be a suitable pad of rubber placed between the face 39 of the generator and the hammer 17d which also forms part of the said generator. In the arrangement considered here by way of example, the springs 19d are deformable metal-rubber elements stacked one on the other.

The pad 38 is of sufficient thickness or has the required characteristics to intercept or deaden the high-frequency vibrations and abnormally-high shocks. Nevertheless, it should not flatten too much so as to avoid troublesome work and heating, and also to avoid damping of the shocks or percussions to be transmitted to the member which is being driven or extracted.

To this end, as shown in the diagram of FIG. 10, the rubber shock-absorber 38 is not only placed between the face 39 of the generator and the hammer 17d, but is also surrounded by the profile 40 of a part which is rigidly fixed to a part 39 or 17d of the assembly of the generator 14d.

It is already in abutment against this profile 40 when the machine is stopped, as a result of the mechanical load and when so required, of a slight pre-stress. During the course of operation, its deformation 41-42 is controlled, the volume of expansion diminishing as the impulses or shocks increase, which are transmitted to the member to be driven or extracted.

A further arrangement in accordance with the invention is shown in FIG. 11. In this figure, the impulse generator with fly-wheels 15e and eccentric weights 16e comprises motors 37 fixed to the driving casings of the fly-wheels. An assembly comprising the guiding rods 10e (replacing the frame 10 of the previous figures), the cross-beam 20e rigidly fixed to this rod, the spring 11e also serving as the avail 18e is fixed to the sheet-piling 12 to be driven. A hammer or ram 17e, which is rigidly fixed to the generator 14e by means of a pneumatic or hydraulic belt 38e, replaces the pad 38 of FIG. 9.

The said belt having limited and controlled deformations is remarkably effective and ensures the possibility of arranging the motors 37 in the impulse generator, even if there is not provided between them and this generator an elastic coupling of any kind such as has always been proposed up to the present time.

It will be understood that the arrangements which have been described above have no limitative nature and may comprise all the alternative forms of construction, without thereby departing from the scope of the present invention.
What we claim is:

A device for acting on piles, tubing, sheet-piling and the like, both for their driving and their extraction, comprising a frame adapted to be rigidly fixed to the pile, said frame including a base plate for engaging the pile, guiding means parallel to the axis of the pile, a cross member coupling said guiding means together at their extremities, an impulse generator mounted on said frame and adapted to be guided by said guiding means, spring means arranged between said cross member and the generator for converting the alternating impulses to unidirectional percussions, and additional spring means arranged between said base plate and the impulse generator opposite to said first-mentioned spring means which convert the alternating impulses to unidirectional percussions, said first-mentioned spring means and said additional spring means having a variable compression gradient, the degree of compression of said spring means acting to vary the frequency of the percussions.

References Cited by the Examiner

UNITED STATES PATENTS
1,280,269 10/18 Miller 74—61
2,102,603 12/37 Pinazza 173—49
2,545,245 3/31 Stutz 175—55
2,990,022 6/61 Muller et al. 175—55
3,008,528 11/61 Berthet et al. 175—55

FOREIGN PATENTS
1,131,102 2/57 France.

MILTON KAUFMAN, Primary Examiner.
BROUGHTON G. DURHAM, CHARLES E. O'CONNELL, Examiners.