Aug. 19, 1952 B. PIERRE 2,607,569

CONCRETE TAMPING DEVICE

Filed July 2, 1946 2 SHEETS—SHEET 1

Fig.1

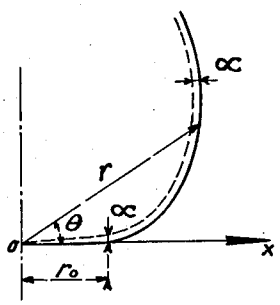


Fig.2

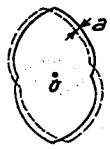


Fig.3

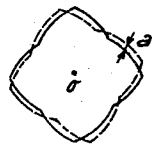


Fig.4

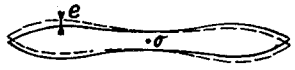


Fig.5



Fig.8

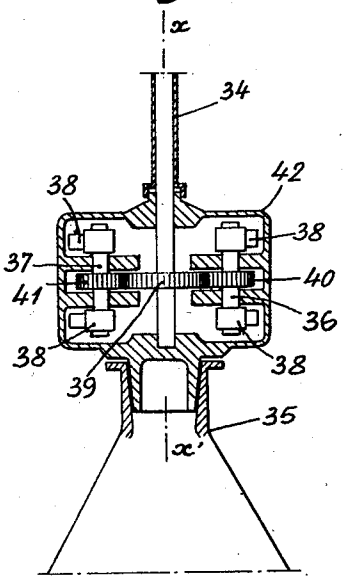
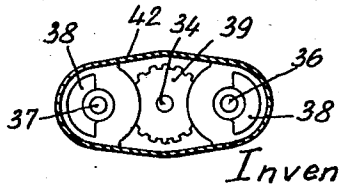


Fig.9



Inventor
B. Pierre
By Wenderoth, Lind & Ponack
Attorneys

Aug. 19, 1952 B. PIERRE 2,607,569

CONCRETE TAMPING DEVICE

Filed July 2, 1946 2 SHEETS—SHEET 2

Fig.6

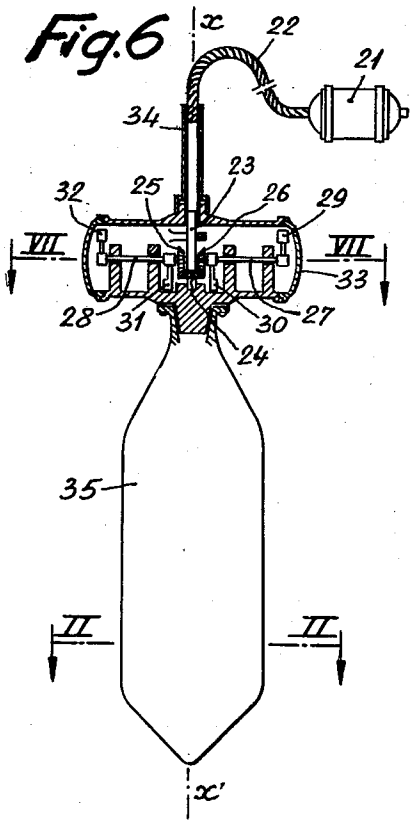


Fig.7

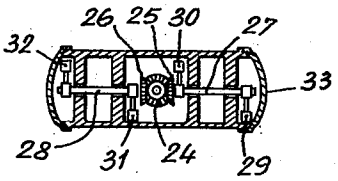
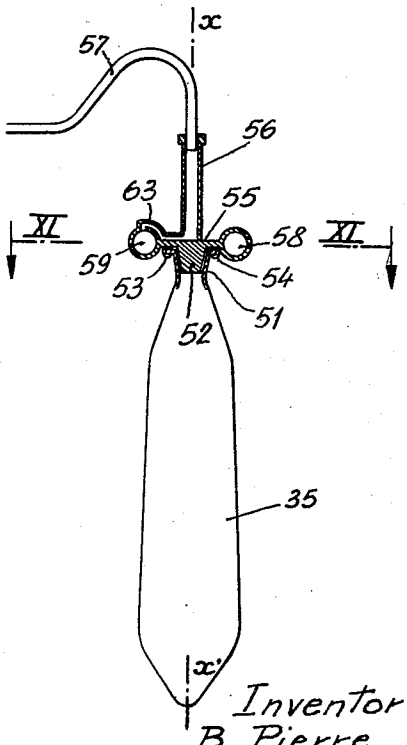


Fig.10



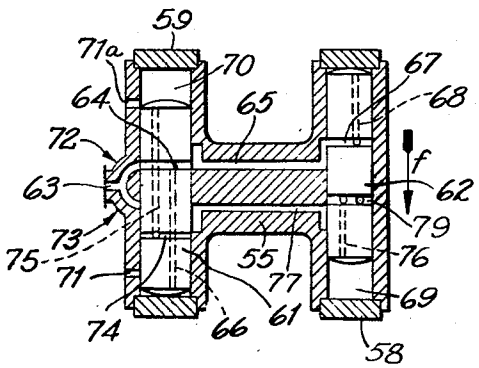


Fig.11

Inventor
B. Pierre
By Wenderoth, Lind & Ponack
Attorneys

Patented Aug. 19, 1952 2,607,569

UNITED STATES PATENT OFFICE

2,607,569

CONCRETE TAMPING DEVICE

Bernard Pierre, Paris, France

Application July 2, 1946, Serial No. 681,098
In France March 16, 1944

Section 1, Public Law 690, August 8, 1946
Patent expires March 16, 1964

4 Claims. (Cl. 259—1)

1

A known way of compacting concrete is to plunge into it the end of a needle maintained in vibration.

Compacting devices operating in this way fall into two main classes according to the sort of vibration communicated in the needle.

(1) In the first class, vibration of the needle is caused by the vibrator (which may be of known type, for example a form vibrator) fixed to the end of the needle protruding from the concrete. The vibrator impresses a rapid oscillatory motion on the point to which it is fixed; and the amplitude of the movement transmitted to different points in the concrete is greater or less according to the mass of the needle handle, according the flexibility of the needle, and according to the depth of penetration of the needle into the concrete. The concrete is compacted more or less satisfactorily but somewhat irregularly.

(2) In the second class, vibration of the needle is caused by an eccentric mass rotating within the needle itself around the longitudinal axis of the needle. As a rule good results are obtained with such a needle because the amplitude of the vibrations transmitted to the concrete is sensibly constant throughout the length of the needle.

But such a needle cannot be used to compact concrete when the concrete is formed in layers (whether vertical or horizontal) of less than 50 mm. thickness, as is the case, notably, in the narrow joints of masonry, and in reinforced concrete with closely spaced reinforcements.

The present invention enables better results to be achieved in all cases than with known devices of the first class; at least as good results are obtained as with known devices of the second class in thicknesses of concrete greater than 45 mm. and also very good results are obtained in lesser thicknesses.

According to the invention these results are obtained by the use of a needle of non-circular section to which is given an alternating movement of rotation, that is to say an oscillation around its longitudinal axis.

In order that all points on the needle may impress equal movement of the designed magnitude upon the concrete in contact with the needle, whatever the distance of these points from the axis of oscillation, the section of the needle by a plane at right angles to the axis of oscillation may with advantage be given the form of a portion of the curve described in polar co-ordinates by the equation

$$\theta=\sqrt{\frac{r^2-r_0^2}{r_0^2}}-\text{arc tg}\sqrt{\frac{r^2-r_0^2}{r_0^2}}$$

where

The origin O is at the centre of oscillation,
The radius vector r makes an angle θ with the axis of co-ordinates Ox.

2

r_0 is the shortest vector at which the oscillation gives the designed displacement to the concrete,

Any means may be employed to impart oscillation to the needle.

Generally speaking the needle will be subjected to an alternating couple about its longitudinal axis.

Preferably the needle is made fast to a part subjected to the action of forces alternating in sense, the directions of which lie both in a plane perpendicular to the longitudinal axis of the needle and in planes sensibly parallel to the axis and symmetrical with respect to it, so that they transmit to the needle a torque alternating in sense.

In a first construction, two shafts turn at the same speed but in opposite directions carry eccentric masses which when they are in the plane containing the shafts and the longitudinal axis of the needle are symmetrical with respect to the longitudinal axis of the needle.

These shafts may be parallel to the longitudinal axis of the needle or they may be co-axial and at right angles to it and carry masses at each of their extremities, the masses on the ends next to the longitudinal axis of the needle being displaced by 180° from the masses at the ends distant from the axis.

In a second construction according to the invention the needle is made fast to a member in which are two cylinders containing double-acting pistons operated by fluid pressure, the axes of the cylinders being at right angles to the longitudinal axis of the needle and symmetrical with respect to it, the pressure fluid driving the pistons in opposite senses so that the forces produced by their simultaneous displacements produce a couple the axis of which is that of the needle.

By way of example there are shown in the accompanying drawings:

In Figure 1 part of the curve above described as the preferred form of the section of the needle;

In Figures 2 to 5 four cross-sections of needles are shown according to the present invention; each cross-section in each figure is shown in two positions, one position is shown in full lines and the other position is shown in dotted lines;

In Figure 6 a view of one construction of the invention partly in section,

In Figure 7 a section on the line VII—VII of Figure 6,

In Figure 8 a section of part of a second construction of the invention;

In Figure 9 a view from above of the construction shown in Figure 8 the top of the casing being removed,

In Figure 10 another construction of the invention;

In Figure 11 a section on the line XI—XI of Figure 10.

The curve shown in full lines in Figure 1 agrees with the equation above given. The curve shown in dotted lines represents the curve shown in full lines after rotation through an angle

$$\frac{\theta}{r_0}$$

and is a curve parallel to the latter and distant θ from it.

Figures 2–5 illustrate various cross-sections of the needle which is a feature of the invention. The non-circular sections of Figures 2–5 are oscillated about the longitudinal axis of the needle, and these sections correspond to the form of the foregoing equation to describe the curve, the foregoing equation expressed in polar coordinates. Each of the cross-sections illustrated in Figures 2–5 indicate two positions for these cross-sections; one of these positions being shown in a full line, the other in dotted line.

In the device shown in Figures 6 and 7 a motor 21 drives through a flexible transmission 22 a shaft 23 on which is secured a bevel pinion 24.

The bevel pinion 24 drives through similar pinions 25 and 26 two shafts 27 and 28 to which it transmits rapid movements of rotation of the same speed and of opposite sense.

Upon the shaft 27 are securely fastened two equal masses 29 and 30 arranged symmetrically with respect to a point on the shaft 27 equidistant from the point at which the masses 29 and 30 are fixed. Shaft 28 and its masses 31 and 32 are identical with the shaft 27 and its masses 29 and 30. At the beginning of the movement the four masses are in the plane containing the longitudinal axis of the needle and the axes of the shafts 27 and 28 the masses 30 and 31 being on the side of the shafts towards the needle point, and the masses 29 and 32 on the side towards the flexible transmission. The shafts 23, 27 and 28, the bevel pinions 24, 25 and 26 and the masses 29, 30, 31 and 32 are enclosed in a casing 33 in which are bearing for the three shafts.

Upon this casing are mounted a handle 34 and a needle 35 co-axial with the handle and of convenient shape, for instance of the section shown in Figure 5; this needle is to be plunged into the concrete.

In consequence of their rapid rotation the masses 29 and 32, when they are in the position shown in Figure 7, create by their centrifugal forces a couple of which the axis is x—x', while the masses 30 and 31 create a much smaller opposite couple, so that there is a resultant tending to turn the casing about the axis x—x'; when the masses are in the position shown in Figure 6 their centrifugal forces produce no couple about the axis x—x'.

So on each revolution of the shafts 27 and 28 the casing makes an oscillation about the axis x—x' carrying with it the needle 35 which is securely fixed to it.

The needle 35 is made, as indicated in Figure 5, of a light metal casting comprising curved elements of the form above described, so designed that the displacement of the needle surface in contact with the concrete has nearly everywhere the desired value.

In the construction shown in Figures 8 and 9 the shafts 36 and 37, instead of being at right angles to the longitudinal axis x—x' of the needle 35 are parallel to it and each carries two masses 38. These are eccentric to the shafts 36 and 37

and are so placed that when they are in the plane containing the shafts 36 and 37 and the axis x—x' they are symmetrical with respect to the axis x—x'. Motion is transmitted to the shaft 34 from an exterior source of movement as in Figure 6 and on shaft 34 is keyed a pinion 39 engaging with identical pinions 40 and 41 keyed upon the respective shafts 36 and 37. The whole construction is arranged in a casing 42 like that shown in Figure 6 and to this casing is secured the needle 35 in manner analogous to that described below in connection with Figure 10.

The working of this arrangement is substantially analogous to that of the construction shown in Figures 6 and 7.

In the construction shown in Figures 10 and 11 the needle 35, of such a shape as has been mentioned above, is secured to a socket 51 of a truncated pyramid form which fits upon a boss 52 of similar polygonal section, and is firmly pressed upon the boss by two screws 53 and 54. The boss 52 is part of a casing 55 secured to a hollow handle 56 to which is joined a flexible compressed air conduit 57.

In the casing 55 are formed two cylinders 58 and 59 in which move heavy pistons 61 and 62. The cylinders lie in a plane perpendicular to the longitudinal axis x—x' of the needle 35, and are symmetrical with respect to that axis. The pistons 61 and 62 are moved by compressed air supplied through the conduit 57 and a passage 63.

In Fig. 11, pistons 61 and 62 located in cylinders 58 and 59 respectively, are reciprocatingly moved by compressed air admitted through passage or groove 64 in cylinder 59, upper passage or groove 65 in casing 55, passage or groove 67 and conduit or passage 68 to enter into chamber 69. Compressed air is likewise admitted via passage or conduit 66 in piston 61 into chamber 70. Air in the upper part of chamber 70 is vented through port 71a. Also, passages 76 in chamber 69 and lower passage 77 in casing 55 at times communicates with passage or groove 74 in cylinder 58 and with passage 75 and port 71a. Passage or groove 79 in cylinder 59 corresponds to passage 74 in cylinder 58.

When one of the pistons 61 and 62 is moving in the direction indicated by the arrow f the other is moving in the opposite direction. The blade 35 is therefore subjected to a alternating movement around its longitudinal axis.

The simultaneous movement of the pistons 61 and 62 may be obtained, for example, by making the piston 61 serve as a slide valve controlling the supply of compressed air to and its exhaust from the cylinder 58.

In the construction illustrated, when it is in the position shown in Figure 11, air supplied by the conduit 63 is led through the groove 64 through the passageway 65 in piston 61 both to the conduit 66 in piston 61 and to the groove 67 and conduit 68 of piston 62, and so to the chambers 69 and 70 in cylinders 58 and 59.

With the pistons in the position shown in Fig. 11 pressure air is admitted via passages 64, 65, 67 and 68 to chamber 69 and also via passage 66 to chamber 70. Pistons 61 and 62 now move to their opposite positions, air in the upper part of chamber 70 venting via port 71a and the air in the lower part of chamber 69 venting via passages 76, lower passage 77 in casing 55, passages 74 and 75 and port 71a.

On reverse operation pressure is admitted to passages 63, 74, lower passage 77 in casing 55, passages 79 and 76 to the lower part of chamber

69 and also to passage 75 to upper part of chamber 70. Air in the other ends of chambers 69 and 70 vent via passages 68, 67, 65, 66, 71 and vent 71*a*, respectively.

Consequently the pistons are vigorously displaced in opposite senses. The forces resulting from these displacements are transmitted by the casing to the needle which is held by means of a handle 56 and is plunged into the concrete against which it presses. These forces constitute a couple the axis of which is the longitudinal axis of the needle, and they make the needle turn about that axis.

When it reaches the end of its cylinder the piston 61 uncovers the port 71 through which the compressed air exhausts. The groove 64 is now no longer in register with the admission port 72, but the groove 74 registers with the opening of passageway 75, and the pistons 61 and 62 are given an opposite movement and create a couple of opposite sign.

With the invention disclosed herein there is secured equal displacements of the concrete in contact with the needle whereby a regular tamping of the concrete is secured. The following calculation shows that the result sought is secured.

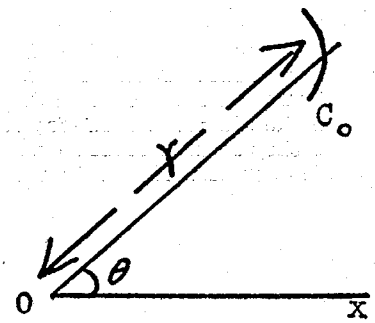
Calculation

Assume the curve (c) is defined by polar coordinates by the equation:

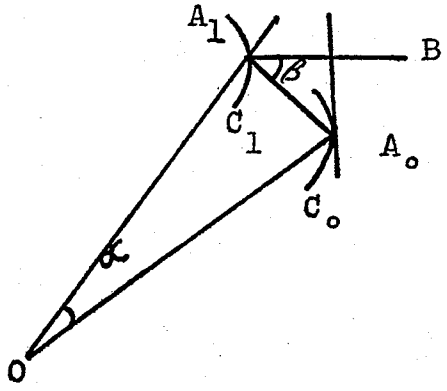
$$\theta=\left(\frac{r^2}{r_0^2}-1\right)^{1/2}-\text{arc tg}\left(\frac{r^2}{r_0^2}-1\right)^{1/2}$$

where r designates the length of the radius vector of a point of the curve and θ the angle of this radius vector with the axis Ox of origin.

We will demonstrate that by rotating this curve (C_0) a small angle α about the origin O, there is obtained a new curve (C_1) for which, for all points wherein $r>r_0$, the distance from the curve (C_0) is constant and equal to αr_0.



Assume that A_0 is a point on the curve (C),



After a rotation through an angle α about O, the point A_0 arrives at A_1 upon the curve C_1. Drop from A_1 a perpendicular A_1B upon the tangent A_0B to the curve C_0 at the point A_0. The angle α being small, the length A_1B represents by the second order almost the distance of a point from the curve (C_1) to the curve (C_0).

Let us represent the length A_1B by X. We have:

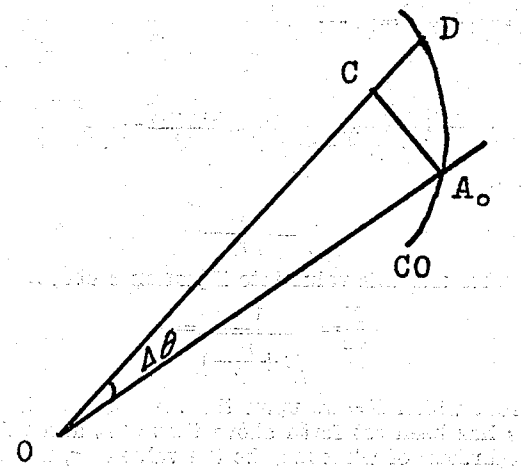
$$(1)\qquad X=\overline{A_0A_1}\cos\beta=r\alpha\cos\beta$$

where β designates the angle A_0A_1B.

Let us now determine the angle β by calculus from the curve C about the point A_0.

An increment $\Delta\theta$ of the angle θ corresponds to an increment Δr of the radius vector.

In the right angular triangle A_0CD we have:



$$CD=\Delta r$$

$$A_0C=r\Delta\theta$$

$$\text{tg } CDA_0=\frac{A_0C}{CD}=\frac{r\Delta\theta}{\Delta r}$$

and at the limit when θ approaches 0,

$$\frac{\Delta\theta}{\Delta r}\text{ approaches }\frac{d\theta}{dr}$$

On the other hand, the angles CDA_0 and β are equal as they have their sides respectively perpendicular so that:

$$(2)\qquad \text{tg }\beta=\frac{rd\theta}{dr}$$

From Equations 1 and 2 we can derive with

$$\cos\beta=\frac{1}{\sqrt{1+\text{tg}^2\,\beta}}$$

$$(3)\qquad \frac{X}{r\alpha}=\frac{1}{\sqrt{1+\left(\frac{rd\theta}{dr}\right)^2}}$$

Let us reckon $rd\theta/dr$ starting from the equation of the curve C_0:

$$\theta=\left(\frac{r^2}{r_0^2}-1\right)^{1/2}-\text{arc tg}\left(\frac{r^2}{r_0^2}-1\right)^{1/2}$$

Let us set:

$$x=\left(\frac{r^2}{r_0^2}-1\right)^{1/2}:y=\frac{r^2}{r_0^2}-1$$

We have:

$$\frac{dy}{dr}=\frac{2r}{r_0^2}$$

$$x=y^{1/2}\text{ and }\frac{dx}{dy}=1/2y^{-1/2}$$

and

$$\frac{dx}{dy}=1/2\cdot\frac{1}{\sqrt{\frac{r^2}{r_0^2}-1}}$$

which is possible if $r^2/r_0^2>1$ that is:

$$r>r_0$$

One has also

$$\theta=x-\text{arc tg } x$$

and

$$\frac{d\theta}{dx}=1-\frac{1}{1+x^2}=1-\frac{1}{1+\frac{r^2}{r_0^2}-1}=1-\frac{r_0^2}{r^2}$$

One has therefore:

$$\frac{d\theta}{dr}=\frac{d\theta}{dx}\cdot\frac{dx}{dy}\cdot\frac{dy}{dr}=\left(1-\frac{r_0^2}{r^2}\right)\cdot\frac{1}{2}\cdot\frac{1}{\sqrt{\frac{r^2}{r_0^2}-1}}\cdot\frac{2r}{r_0^2}$$

$$=\frac{r^2-r_0^2}{r^2}\cdot\frac{1}{2}\cdot\frac{2r_0}{\sqrt{r^2-r_0^2}}\cdot\frac{r}{r_0^2}=\frac{\sqrt{r^2-r_0^2}}{r_0^2}=\sqrt{\frac{1}{r_0^2}-\frac{1}{r^2}}$$

and

$$\frac{rd\theta}{dr}=\sqrt{\frac{r^2}{r_0^2}-1}$$

Transfer this value into Equation 3 above:

$$\frac{X}{r\alpha}=\frac{1}{\sqrt{1+\frac{r^2}{r_0^2}-1}}=\frac{r_0}{r}$$

from which $X=ar_0$ upon the evident condition as has been set forth above that $r>r_0$ and this regardless of what may be the value of r, which was to be shown.

Naturally the invention is not limited to the examples described.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. Apparatus for tamping concrete and analogous material comprising a needle introduced into the mass to be tamped, a vibrator comprising two cylinders whose axes are parallel to one another and perpendicular to the longitudinal axis of said needle and symmetrical with relation to said longitudinal axis, two pistons located

in said cylinders, fluid operated means for operating said pistons in opposite directions, a body fixed to said cylinders and said needle and transmitting the vibrations of the vibrator to said needle.

2. An apparatus as set forth in claim 1 in which one of said pistons serves as a distribution slide valve for said fluid operated means for the other piston.

3. An apparatus as set forth in claim 1 in which the section of said needle through a plane perpendicular to its longitudinal axis is constituted at least in part of portions of a curvature described in polar coordinates by the equation

$$\theta=\left[\sqrt{\frac{r^2}{r_0^2}-1}-\text{arc tg }\sqrt{\frac{r^2}{r_0^2}-1}\right]$$

where the origin O of the co-ordinates is at the longitudinal axis of the needle, the radius vector r makes an angle θ with the axis of co-ordinates Ox and r_0 is the shortest radius vector at which alternating rotation gives the described displacement of the concrete.

4. In a tool for compacting concrete or like materials, a needle insertable in the mass to be compacted, said needle having a cross section formed at least in part of portions of the curve described in polar co-ordinates by the equation

$$\theta=\left[\sqrt{\frac{r^2}{r_0^2}-1}-\text{arc tg }\sqrt{\frac{r^2}{r_0^2}-1}\right]$$

where the origin O of the co-ordinates is at the longitudinal axis of the needle, the radius vector r makes an angle θ with the axis of co-ordinates Ox and r_0 is the shortest radius vector at which alternating rotation gives the described displacement of the concrete.

BERNARD PIERRE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,221,038	Earle	Apr. 3, 1917
1,875,622	Lockwood	Sept. 6, 1932
1,911,966	Pickop	May 30, 1933
2,020,374	Pickop	Nov. 12, 1935
2,075,093	Cannon	Mar. 30, 1937