THIS SHEET HAS BEEN REPLACED

"DEVICE TO DETECT THE SPEED PROFILE OF CONCRETE FLOWING INTO A PIPELINE"

===o0o===

The present invention concerns a device to detect the speed profile of concrete inside a pipeline with radial symmetry through which said concrete is caused to flow.

There are already known to be processes and devices to detect the speed profile of heterogeneous fluid mixtures flowing through ducts. Such processes and devices have generally been developed in the medical and biological field, for organic and/or physiological liquids of limited density and low viscosity - as, for example, blood - the dishomogeneities of which have dimensions of several magnitude orders below the size of the ducts through which they flow, which are of small or very small dimensions.

Whereas, the problem had never been faced to detect the speed profile of fluids having a high density and a very high viscosity, such as concrete, the dishomogeneities of which have dimensions of the same magnitude order as those of the ducts - always pipelines of wide diameter - through which they flow.

The present invention faces and solves this problem by supplying a device to detect the speed profile of concrete inside a pipeline with radial symmetry, through which the concrete is caused to flow. Said device - of the type comprising acoustical probe means, apt to send through said pipeline, and the concrete flowing therein, a supersonic ray inclined in respect of the pipeline axis, and to receive a disturbed supersonic ray in response, as well as an electronic circuit, apt to analyse the signals sent by said probe means and obtain therefrom a diagram showing the speed profile of the concrete - is characterized in that, said probe means make use of a supersonic ray of frequency between 20 and 500 KHz, and in that said electronic circuit processes the signals sent by the probe means, indicating the speed, with an updating frequency from 10 to 70 times per second, and deprives said signals from their components derived from the propagation rate in the concrete, to obtain a measurement of the speed

This Sheet Has Been Replaced



THIS SHEET HAS BEEN REPLACED

along the acoustical axis, which is not relative and has its own sign.

Said detection device allows to display said speed measurements as a speed profile. Moreover, it allows measuring the flow rate, as a speed integral on the section area, and it also allows viscosity measurements as first derivatives of the speed in the space, as well as granulometry and density measurements through a statistical analysis of a packet of speed profiles.

For economical reasons and to simplify construction and operation it is usually convenient to adopt, in the detection device according to the invention, probe means wherein the transmitting and receiving probes coincide. Suitably, such probe means shall be applied on said pipeline so that the supersonic ray, of which use is made, is inclined by 15° to 75° in respect of the pipeline axis.

The invention will now be described in further detail with reference to the accompanying drawings, which illustrate a preferred embodiment of the detection device defined heretofore, and in which:

Fig. 1 represents a block diagram of the detection device according to the invention;

Figs. 2 and 2A are diagrams illustrating, in two orthogonal sections, the application of the acoustical probe, forming part of the detection device of fig. 1, to a pipeline for concrete distribution;

Fig. 3 illustrates the propagation, in said pipeline, of the supersonic ray emitted by said probe into the various concrete components crossed by said ray; and

Fig. 4 represents an example of speed profile of the concrete caused to flow into a distribution pipeline, such as it is displayed in the detection device according to the invention.

With reference to the drawings, the detection device according to the invention is of the type making use of a supersonic ray r (figs. 1 and 2), of frequency between 20 and 500 KHz, sent across the concrete flowing through a pipeline C; said device operates by detecting the disturbance appearing on the ray r' of response (figs. 1 and 2A), in

This Sheet Has Been Replaced



THIS SHEET HAS BEEN REPLACED

function of the irregularities deriving from the heterogeneous composition of the concrete, which influence the propagation of said ray r'.

The detection device is applied on the pipeline C so that the supersonic ray, of which use is made, is inclined by 15° to 75° in respect of the axis of said pipeline (fig. 2).

As shown in fig. 1, said device consists of a transmitting probe 1, which sends the supersonic ray r suitably inclined towards the pipeline C through which the concrete flows, so as to cross this latter and be disturbed and propagated thereby, of a receiving probe 2, which collects the disturbed ray r emerging from the pipeline C, and of a reception circuit to which are fed signals produced by the receiving probe 2. The receiving probe 2 is positioned on the same plane as the transmitting probe 1, forming any angle α therewith (see fig. 2A), and it may also coincide - it is preferably caused to coincide (as shown in fig. 2), with advantages as far as costs and simplicity of the device - with the transmitting probe.

In the reception circuit, the signals sent by the receiving probe 2 are amplified by a logarithmic amplifier 3, with a gain which varies according to time, that is, to the distances of the propagation points from which the signals are issued.

The amplified signals are sent to a wattless decomposition circuit 4: this is a simple circuit (preferably, a very cheap RC unit) which recovers the real part and the imaginary part of the signals, sending them separately to the shunting circuits 5 and 6, which are controlled by a sampling circuit 7. In the shunting circuits 5 and 6 (preferably, two simple and economic digital shunts) the real and imaginary parts of the signals are shunted. The shunting time base of the shunts 5 and 6 is chosen so that, to each instant there corresponds a position in space of the echo-signal advancing in the pipeline C: one thereby analyses, so as to be able to obtain the desired profile, the concrete mass moving into the pipeline C, section by section, along the axis of the supersonic ray and at preset distances from the sampling interval. Fig. 2 illustrates, by way of example, a series of sections s.

This Sheet Has Been Replaced

THIS SHEET HAS BEEN REPLACED

The signal issued by the shunting circuit 5 is multiplied by the signal issued by the shunting circuit 6 and is sent to the correlator 9, while the signal issued by the shunting circuit 6 is changed of sign, is multiplied by the signal issued by the shunting circuit 5 and is then sent to the correlator 8. The correlators 8 and 9 are controlled by the sampling circuit 7. In said circuits, the real and imaginary parts of the signals of each section are correlated so that it may be possible to recover the speed, along the axis of the supersonic ray, of the particles in each section. By identifying the walls of the pipeline as the sections which, by definition, are speedless, it is possible to render the measurement independent from the speed of propagation in the concrete (the particular concrete in the special conditions in which it is while flowing into the pipeline C) and from the refraction angle of the supersonic ray in the pipeline wall-concrete passage (see fig. 3), and to obtain an absolute measurement (and not a relative one, as it happened in the known detection devices used in the medical and biological field) of the speed in each section (each measurement with its own sign). The processing should occur with an updating frequency by the sampling circuit 7 of at least 10 to 70 times per second, taking into account the characteristics of very high dishomogeneity of the concrete, and the fact that concrete is usually distributed with an alternative pump, with consequent irregularities in its feeding motion.

In the correlation circuits a mean operation is thus carried out, allowing to clear from the noise the single signals before sending them to the processor 10 of the reception circuit.

Said processor then joins again the real and imaginary parts of the signals, performing also a filtering operation, and it provides to draw from the speed values (each with its own sign) the desired profile, which is thus evidenced onto a display, as illustrated by way of example in fig. 4 (where $\underline{v}$ indicates the speed - ordinates - and $\underline{d}$ represents - abscissae - the diamater of the pipeline C, through which the concrete is caused to flow).

This Sheet Has Been Replaced

THIS SHEET HAS BEEN REPLACED

Once having recovered the speed values in each section, with the same processor 10 it is also possible to determine, through ordinary electronic computation processes, the flow rate (as speed integral on the section area), the viscosity (as derivative of the speed in the space), and the granulometry (by a statistical analysis of a packet of speed profiles) of the concrete flowing into the pipeline C.

The possibility to determine all these physical quantities finally allows to guarantee a certification to the concrete fed through a pipeline C equipped with the detection device of the present invention.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN REPLACED

CLAIMS

1) Device to detect the speed profile of concrete inside a pipeline with radial symmetry through which the concrete is caused to flow - of the type comprising acoustical probe means, apt to send through said pipeline, and the concrete flowing therein, a supersonic ray inclined in respect of the pipeline axis, and to receive a disturbed supersonic ray in response, as well as an electronic circuit, apt to analyse the signals sent by said probe means and obtain therefrom a diagram showing the speed profile of the concrete - characterized in that, said probe means make use of a supersonic ray of frequency between 20 and 500 KHz, and in that said electronic circuit processes the signals sent by the probe means, indicating the speed, with an updating frequency from 10 to 70 times per second, and deprives said signals from their components derived from the propagation rate in the concrete, to obtain a measurement of the speed along the acoustical axis, which is not relative and has its own sign.

2) Device as in claim 1), wherein said speed measurements are displayed as a speed profile.

3) Device as in claims 1) and 2), wherein the flow rate is measured as a speed integral on the section area.

4) Device as in claims 1) to 3), wherein viscosity measurements are obtained as first derivatives of the speed in the space.

5) Device as in claims 1) to 4), wherein granulometry and density measurements are obtained through a statistical analysis of a packet of speed profiles.

6) Device as in claims 1) to 5), wherein probe means are adopted, in which the transmitting and receiving probes coincide.

7) Device as in claims 1) to 6), wherein said probe means are applied on said pipeline so that the supersonic ray, of which use is made, is inclined by 15° to 75° in respect of the pipeline axis.

8) Device as in claims 1) to 7), wherein a certification of the concrete fed through said pipeline is obtained.

This Sheet Has Been Replaced

* C L M S *

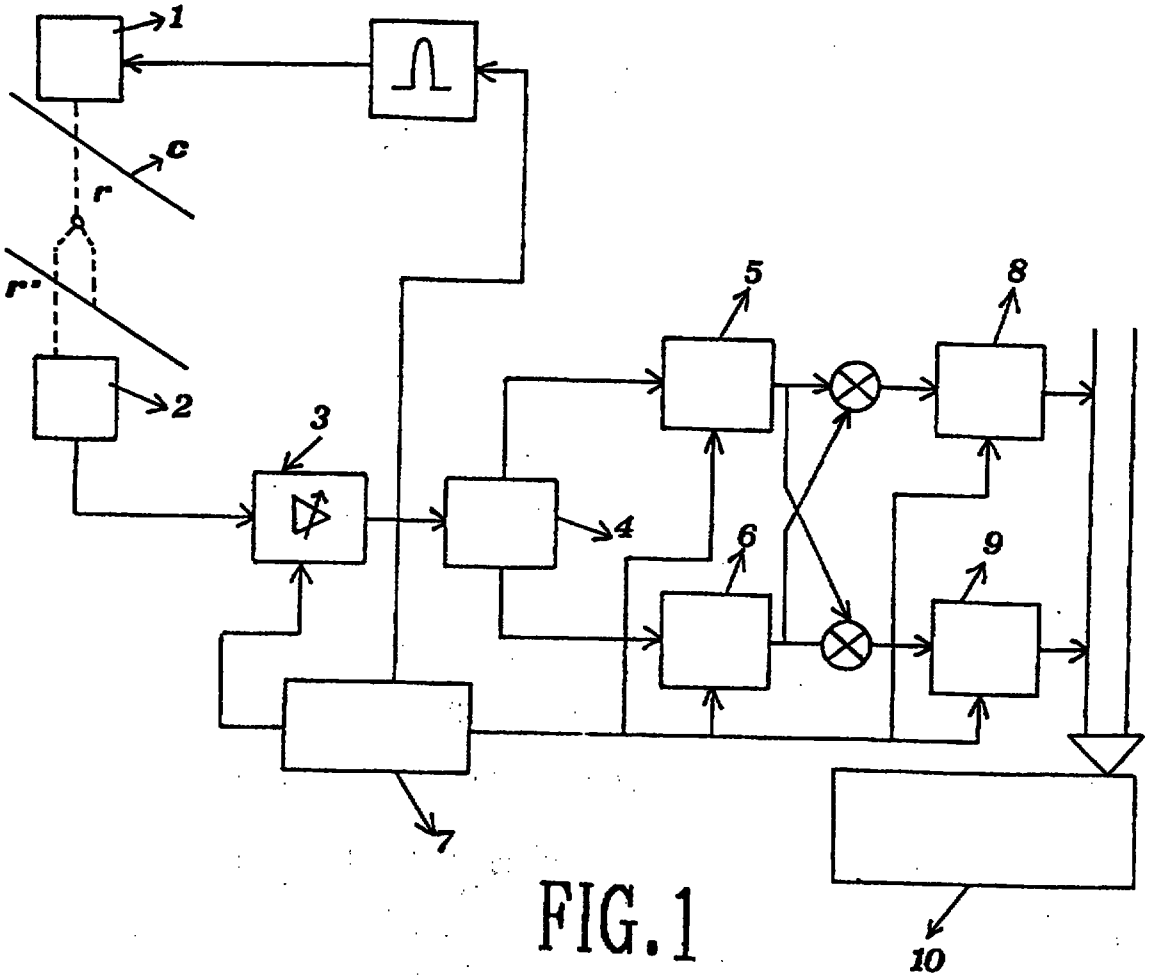


FIG.1

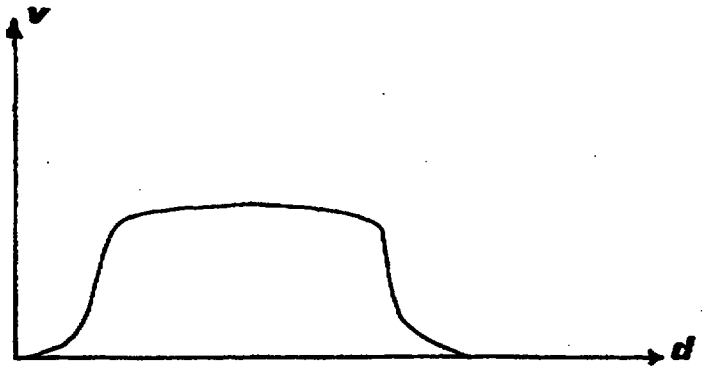


FIG.4

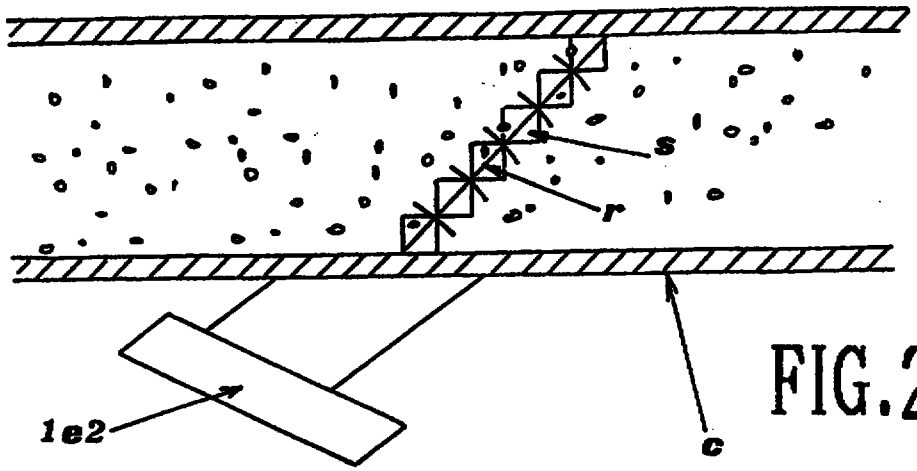


FIG.2

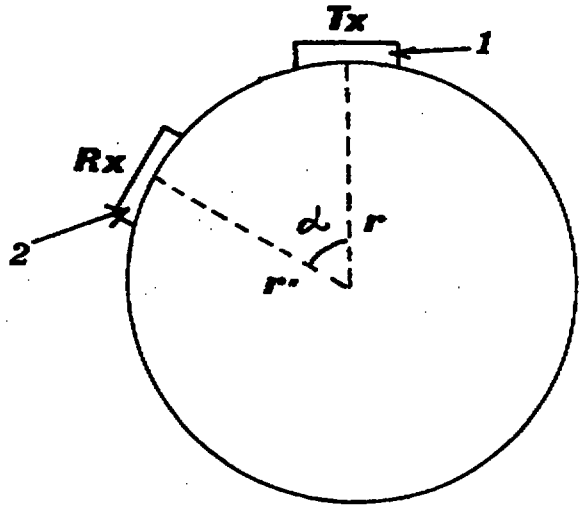


FIG.2a

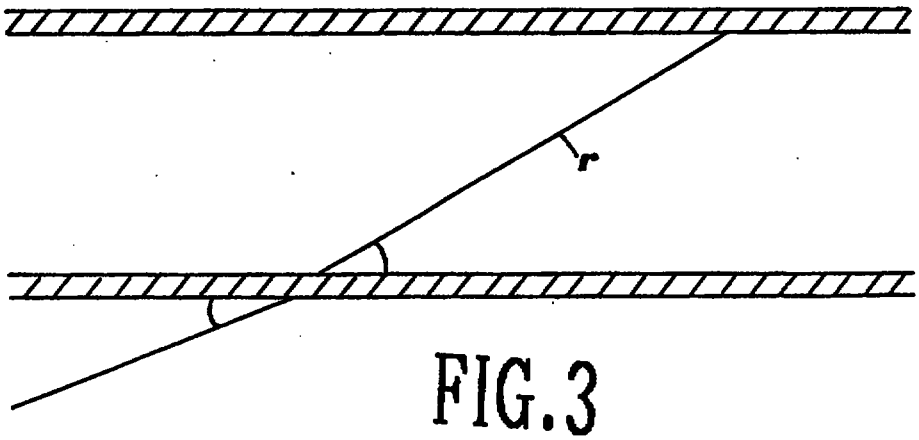


FIG.3

980253-9
REPLACEMENT SHEET
Ipos
REPLACEMENT SHEET
07 OCT 1999

"DEVICE TO DETECT THE ~~SPEED PROFILE~~ OF CONCRETE FLOWING INTO A PIPELINE"

===o0o===

The present invention concerns a device to detect the speed profile of concrete inside a pipeline with radial symmetry through which said concrete is caused to flow.

There are already known to be processes and devices to detect the speed profile of heterogeneous fluid mixtures flowing through ducts. Such processes and devices have generally been developed in the medical and biological field, for organic and/or physiological liquids of limited density and low viscosity - as, for example, blood - the dishomogeneities of which have dimensions of several magnitude orders below the size of the ducts through which they flow, which are of small or very small dimensions.

Whereas, the problem had never been faced to detect the speed profile of fluids having a high density and a very high viscosity, such as concrete, the dishomogeneities of which have dimensions of the same magnitude order as those of the ducts - always pipelines of wide diameter - through which they flow.

Indeed in the prior art comprises:

- the publication D1, relative to a tomographic method using ultrasounds in the technical domain: the subject matter of this publication is completely alien to the problem faced and solved by the present invention;
- the patent D2, which makes a measurement similar to the one of the invention with the use of an inclined ultrasonic ray, but makes such a measurement in liquid or pasty fluids not unhomogeneous like concrete; thus it does not solve the problem of the invention;
- the publication D3, which refers to measurement using ultrasounds in cements, where, as known, the ultrasound phenomenon is not a propagation (as in the concrete, in which the measurement of the invention is interested) but a diffusion; therefore it does not give interesting information on the problem of the invention;
- and the publication D4, which uses ultrasounds too, but with the aim of testing materials and not for the aims of the invention.

The above cited problem is instead faced and solved by the present invention, which supply a

REPLACEMENT SHEET
07 OCT 1999

REPLACEMENT SHEET

device to detect the speed profile of concrete inside a pipeline with radial symmetry, through which the concrete is caused to flow. Said device - of the type comprising acoustical probe means, apt to send through said pipeline, and the concrete flowing therein, a supersonic ray inclined in respect of the pipeline axis, and to receive a disturbed supersonic ray in response, as well as an electronic circuit, apt to analyse the signals sent by said probe means and obtain therefrom a diagram showing the speed profile of the concrete - is characterized in that, said probe means make use of a supersonic ray of frequency between 20 and 500 KHz, and in that said electronic circuit processes the signals sent by the probe means, indicating the speed, with an updating frequency from 10 to 70 times per second, and deprives said signals from their components derived from the propagation rate in the concrete, to obtain a measurement of the speed along the acoustical axis, which is not relative and has its own sign.

Said detection device allows to display said speed measurements as a speed profile. Moreover, it allows measuring the flow rate, as a speed integral on the section area, and it also allows viscosity measurements as first derivatives of the speed in the space, as well as granulometry and density measurements through a statistical analysis of a packet of speed profiles.

For economical reasons and to simplify construction and operation it is usually convenient to adopt, in the detection device according to the invention, probe means wherein the transmitting and receiving probes coincide. Suitably, such probe means shall be applied on said pipeline so that the supersonic ray, of which use is made, is inclined by 15° to 75° in respect of the pipeline axis.

The invention will now be described in further detail with reference to the accompanying drawings, which illustrate a preferred embodiment of the detection device defined heretofore, and in which:

Fig. 1 represents a block diagram of the detection device according to the invention;

Figs. 2 and 2A are diagrams illustrating, in two orthogonal sections, the application of the acoustical probe, forming part of the detection device of fig. 1, to a pipeline for concrete distribution;

Fig. 3 illustrates the propagation, in said pipeline, of the supersonic ray emitted by said probe into the various concrete components crossed by said ray; and

Fig. 4 represents an example of speed profile of the concrete caused to flow into a distribution pipeline, such as it is displayed in the detection device according to the invention.

With reference to the drawings, the detection device according to the invention is of the type making use of a supersonic ray r (figs. 1 and 2), of frequency between 20 and 500 KHz, sent across the concrete flowing through a pipeline C; said device operates by detecting the disturbance appearing on the ray r' of response (figs. 1 and 2A), in function of the irregularities deriving from the heterogeneous composition of the concrete, which influence the propagation of said ray r'.

The detection device is applied on the pipeline C so that the supersonic ray, of which use is made, is inclined by 15° to 75° in respect of the axis of said pipeline (fig. 2).

As shown in fig. 1, said device consists of a transmitting probe 1, which sends the supersonic ray r suitably inclined towards the pipeline C through which the concrete flows, so as to cross this latter and be disturbed and propagated thereby, of a receiving probe 2, which collects the disturbed ray r emerging from the pipeline C, and of a reception circuit to which are fed signals produced by the receiving probe 2. The receiving probe 2 is positioned on the same plane as the transmitting probe 1, forming any angle α therewith (see fig. 2A), and it may also coincide - it is preferably caused to coincide (as shown in fig. 2), with advantages as far as costs and simplicity of the device - with the transmitting probe.

In the reception circuit, the signals sent by the receiving probe 2 are amplified by a logarithmic amplifier 3, with a gain which varies according to time, that is, to the distances of the propagation points from which the signals are issued.

The amplified signals are sent to a wattless decomposition circuit 4: this is a simple circuit (preferably, a very cheap RC unit) which re-

REPLACEMENT SHEET
07 OCT 1999

covers the real ~~part and the imaginary~~ part of the signals, sending them separately to the shunting circuits 5 and 6, which are controlled by a sampling circuit 7. In the shunting circuits 5 and 6 (preferably, two simple and economic digital shunts) the real and imaginary parts of the signals are shunted. The shunting time base of the shunts 5 and 6 is chosen so that, to each instant there corresponds a position in space of the echo-signal advancing in the pipeline C: one thereby analyses, so as to be able to obtain the desired profile, the concrete mass moving into the pipeline C, section by section, along the axis of the supersonic ray and at preset distances from the sampling interval. Fig. 2 illustrates, by way of example, a series of sections s.

The signal issued by the shunting circuit 5 is multiplied by the signal issued by the shunting circuit 6 and is sent to the correlator 9, while the signal issued by the shunting circuit 6 is changed of sign, is multiplied by the signal issued by the shunting circuit 5 and is then sent to the correlator 8. The correlators 8 and 9 are controlled by the sampling circuit 7. In said circuits, the real and imaginary parts of the signals of each section are correlated so that it may be possible to recover the speed, along the axis of the supersonic ray, of the particles in each section. By identifying the walls of the pipeline as the sections which, by definition, are speedless, it is possible to render the measurement independent from the speed of propagation in the concrete (the particular concrete in the special conditions in which it is while flowing into the pipeline C) and from the refraction angle of the supersonic ray in the pipeline wall-concrete passage (see fig. 3), and to obtain an absolute measurement (and not a relative one, as it happened in the known detection devices used in the medical and biological field) of the speed in each section (each measurement with its own sign). The processing should occur with an updating frequency by the sampling circuit 7 of at least 10 to 70 times per second, taking into account the characteristics of very high dishomogeneity of the concrete, and the fact that concrete

REPLACEMENT SHEET

07 OCT 1999

is usually distributed with an alternative pump, with consequent irregularities in its feeding motion.

In the correlation circuits a mean operation is thus carried out, allowing to clear from the noise the single signals before sending them to the processor 10 of the reception circuit.

Said processor then joins again the real and imaginary parts of the signals, performing also a filtering operation, and it provides to draw from the speed values (each with its own sign) the desired profile, which is thus evidenced onto a display, as illustrated by way of example in fig. 4 (where $\underline{v}$ indicates the speed - ordinates - and $\underline{d}$ represents - abscissae - the diamater of the pipeline C, through which the concrete is caused to flow).

Once having recovered the speed values in each section, with the same processor 10 it is also possible to determine, through ordinary electronic computation processes, the flow rate (as speed integral on the section area), the viscosity (as derivative of the speed in the space), and the granulometry (by a statistical analysis of a packet of speed profiles) of the concrete flowing into the pipeline C.

The possibility to determine all these physical quantities finally allows to guarantee a certification to the concrete fed through a pipeline C equipped with the detection device of the present invention.

REPLACEMENT SHEET
07 OCT 1999

CLAIMS

1) Device to detect the speed profile of concrete inside a pipeline (c) with radial symmetry through which the concrete is caused to flow – of the type comprising acoustical probe means (1, 2), apt to send through said pipeline (c), and the concrete flowing therein, a supersonic ray (2) inclined in respect of the pipeline axis, and to receive a disturbed supersonic ray in response, as well as an electronic circuit (Fig. 1), apt to analyze the signals sent by said probe means (1, 2) and obtain therefrom a diagram showing the speed profile of the concrete – characterized in that, said supersonic ray (2) has a frequency comprised between 20 and 500 KHz, and in that said electronic circuit comprises means to process the signals sent by said probe means (1, 2), indicating the speed, with an updating frequency from 10 to 70 times per second, and means to deprives said signals from their components derived from the propagation rate in the concrete, a measurement of the speed along the acoustical axis being obtained, which is not relative and has its own sign.

2) Device as in claim 1), wherein said speed measurements are displayed as a speed profile.

3) Device as in claim 1), wherein the flow rate is measured as a speed integral on the section area.

4) Device as in claim 1), wherein viscosity measurements are obtained as first derivatives of the speed in the space.

5) Device as in claim 1), wherein granulometry and density measurements are obtained through a statistical analysis of a packet of speed profiles.

6) Device as in claims 1) to 5), wherein probe means (1, 2) are adopted, in which the transmitting and receiving probes coincide.

7) Device as in claims 1) to 6), wherein said probe means (1, 2) are applied on said pipeline (c) so that the supersonic ray (2), of which use is made, is inclined by 15° to 75° in respect of the pipeline axis.

* C L M S *

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G01N 29/02

A1

(11) International Publication Number: WO 97/40372

(43) International Publication Date: 30 October 1997 (30.10.97)

(21) International Application Number: PCT/EP97/02071

(22) International Filing Date: 23 April 1997 (23.04.97)

(30) Priority Data:
MI96A000812 24 April 1996 (24.04.96) IT

(71) Applicant (*for all designated States except US*): CIFA S.P.A. [IT/IT]; Viale Rimembranze, 2, I-20026 Novate Milanese (IT).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): MORETTI, Giorgio [IT/IT]; Via Clerici, I-21040 Gerenzano (IT). VENTURINO, Gianfranco [IT/IT]; Via Pergola, 9, I-20100 Milano (IT).

(74) Agents: VATTI, Paolo et al.; Fumero Studio Consulenza Brevetti S.n.c., Via S. Agnese, 12, I-20123 Milano (IT).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: DEVICE TO DETECT THE SPEED PROFILE OF CONCRETE FLOWING INTO A PIPELINE

(57) Abstract

A device to detect the speed profile of concrete flowing through a pipeline with radial symmetry comprises acoustical probe means, apt to send through said pipeline and the concrete a supersonic ray inclined in respect of the pipeline axis and to receive a disturbed supersonic ray in response, as well as an electronic circuit apt to analyse the signals sent by said probe means and obtain therefrom a diagram showing the speed profile of the concrete. According to the invention, said probe means make use of a supersonic ray of frequency between 20 and 500 KHz, and said electronic circuit processes the signals sent by the probe means, indicating the speed, with an updating frequency from 10 to 70 times per second and deprives said signals from their components derived from the propagation rate in the concrete, to obtain a measurement of the speed along the acoustical axis, which is not relative and has its own sign.

