Dutch patent. Application number 229336. Filed on 8 Oct. 2008

UITVINDING AANMELDINGSFORMULIER TU/e

VERTROUWELIJK

DATUM: ***15 MEI 2008***

Invullen de blokken 1, 2 en 3 en de gegevens van de uitvinders op de laatste pagina !

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Zijn er andere dan TU/e medewerkers (studenten, fellows etc.) bij de totstandkoming van de vinding betrokken? ***Nee***

1 TITEL: ***SENSOR AND SYSTEM FOR FLUID FLOW SIMULATION***

2 Is de VINDING voortgekomen uit 1e/2e/3e geldstroomonderzoek? ***Ja, 3e***

a. Zo ja, met welke contractpartners? (EG/NOVEM/SENTER/IOP/NWO/STW/SON/FOM) of andere: ***STIMULUS3, EDC, MMC***
b. Wordt (een van) de uitvinder(s) uit een andere geldbron dan de eerste geldstroom betaald? Zo ja, welke. ***Uitvinders schrijven uren op STIMULUS3 project***

3 PROBLEEMSTELLING

a. Voor welke probleem is een oplossing gevonden? ***To simulate a umbilical cord or another assembly of veins and or arteries used for training of medical workers, training for first aid tasks in areas such as surgery, obstetrics and acute care paramedics. The invention simulates the effects and consequences of bending, blocking or otherwise obstructing the flow in a fluid channel such as typically but not exclusively the blood flow.***

b. Op welke wijze wordt tot nu toe het probleem ondervangen? ***Present-day delivery simulators do not detect any status of the simulated umbilical cord (some baby manikins have a traction sensor in the neck, that's all). In other words: the existing simulators are not very sophisticated.***

De vragen onder punt 4 en 5 geven een indicatie van de onderwerpen die aan de orde komen in een nog via TU/e Innovaton Lab te plannen gesprek met een octrooigemachtigde. Het advies van de octrooigemachtigde zal worden meegenomen in het uiteindelijke besluit van TU/e Innovation Lab, gehoord hebbende de Octrooiadviescommissie, om al dan niet een octrooiaanvraag in te dienen.

4 NIEUWHEID

a. Is er een onderzoek naar de nieuwheid verricht? ***Uitvinders hebben in esp@cenet database gezocht. Zie bijlage sectie "state of the art"***
b. Zijn er verwante/relevante octrooien bekend? ***Nee, zie bijlage sectie "state of the art"***
c. Zijn er publicaties e.d. verwant aan de vinding bekend? ***Nee***

d. Wordt de vinding binnenkort openbaar gemaakt (ook d.m.v. foto's, tekeningen, op symposia, internet!)? ***Nog niet, het lijkt gepast om met MMC en EDC te praten, maar liever eerst patent geregeld.***

5 OPLOSSING(SMETHODE)

a. Op welke wijze wordt met de vinding het probleem opgelost? ***The system sends an acoustical signal into a tube from one end and receives the same signal at the other end. If the tube is being squeezed, this will be detected by a weakening or absence of the acoustical signal.***

b. Geef een beschrijving van de nieuwe of verbeterde werkwijze/product. Geef kort en in begrijpelijke taal weer wat de vinding doet/kan, en hoe het werkt. ***The system contains a flexible tube the outside material and touch-related properties of which resemble the same of the real vessel that is being simulated. Those properties include the stiffness of the tube and its resistance against bending and twisting. The system sends an acoustical signal into the tube from one end and receives the same signal at the other end. If the tube is being squeezed, this will be detected by a weakening or absence of the acoustical signal. The system can easily be made to have a very natural look and feel without any real fluid flowing around. This precisely satisfies the need for simulation purposes in medical training. The system is very robust in the sense that its operation does not depend critically on material properties, tube length, sensor tuning etcetera. Moreover the system is insensitive to external noise because the receiver contains a band pass filter for the acoustic signal used and thus rejects other frequencies. The system is cheap because all components are cheap, particularly the tube, the speaker, the microphone, the oscillator and the filter, none of which demand high precision components or fittings. The sender and the receiver need not be coupled, they each can run on their own power supply. Sender can be switched on and receiver can be listened to via a computerized message interface or via any conventional analog or digital electronics interface.***

c. Geef aan welke delen van het product en stappen in de werkwijze nieuw zijn. ***zie bijlage sectie "state of the art"***

d. Is de vinding gemakkelijk na te maken/te omzeilen (alternatieven)? ***Nee***

De vragen onder punt 6 en 7 geven een indicatie van de onderwerpen die aan de orde komen in een nog te plannen gesprek via TU/e Innovation Lab over de commerciële potentie van de vinding. Het advies over de commerciële mogelijkheden van de vinding zal worden meegenomen in het uiteindelijke besluit van TU/e Innovation Lab, gehoord hebbende de Octrooiadviescommissie, om al dan niet een octrooiaanvraag in te dienen.

6 STADIUM

a. Is de vinding een idee/ontwerp/model/prototype of reeds productierijp? ***Idee en eerste ontwerp.***

b. Geef aan welke (wetenschappelijke) resultaten met de nieuwe vinding bereikt zijn. ***Het is een bijdrage aan een veel grotere activiteit terzake bevallingssimulatie, die weer past in een nog groter onderzoeksproject over perinatologie samen met MMC, faculteit E, TN etc.***

c. Is verdere ontwikkeling voorzien of volgens u nodig? ***Ja, er zijn trouwens nog meer uitvindingen op dit gebied in ontwikkeling, deze is de eerste van een reeks.***

d. Zo ja hoe, wat en waar zou dat dan gedaan moeten worden? ***Binnen de reeds geplande projecten waarin ook MMC, E, TN en bedrijf EDC een rol spelen. Er vindt ook simulatorenontwikkeling plaats door derden zoals METI en Laerdal. Van METI is bekend dat ze aan een zeer verfijnde bevallingssimulator werken, maar de werking daarvan zal wel geheim blijven totdat ze rond 2010 ermee op de markt komen. Met Laerdal wordt overlegd over samenwerking (Europees project BIRTH ingediend).***

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7 POTENTIELE GEBRUIKERS

a. Wat is volgens u het commerciële gebruik van de vinding? ***In simulatoren die weer in medische trainingscentra gebruikt worden. Medische training is een snelgroeiend gebied, in Nederland gecoördineerd door de in 2007 opgerichte DSSH. MMC investeert in perinatologie en in de bouw van een simulatiecentrum. Volgens Prof. Oei M.D. ontstaat er een situatie zoals in de luchtvaart: net zoals piloten regelmatig bijna-crashes e.d. oefenen in de simulator, zo zal elk ziekenhuis zijn teams ook regelmatig moeten trainen.***

b. Welke bedrijven zijn potentieel geïnteresseerd in de vinding en waarom? ***METI, Laerdal, EDC, Gaumard, Limbs and things. Simulatoren zijn een groeiende markt. De TU/e is sinds minder dan een jaar actief, maar zal voorlopig zelf geen leverancier van complete simulatoren worden. Maar wel van deeloplossingen die technisch superieur zijn. Uitvinders voorzien ook dat uiteindelijk de simulatoren een meer open architectuur gaan krijgen.***

c. Kunt u een indicatie geven van de marktomvang, investeringskosten, productiekosten?

d. Welke producten die met de vinding kunnen concurreren, zijn nu op de markt verkrijgbaar?

e. Zijn er reeds bestaande contacten op het terrein van de uitvinding?

f. Hebben anderen al kennis genomen van de vinding?

g. Zijn er partners/co-financiers bekend die aan de doorontwikkeling en/of octrooi-aanvrage willen bijdragen?

h. Indien de vinding niet "aanslaat" in de industrie wat zou volgens u daar dan de belangrijkste reden van zijn?

De door u op te geven gegevens zullen noodzakelijk zijn bij het eventueel indienen van een octrooiaanvraag en zullen door ons strikt vertrouwelijk behandeld worden.

Bij ontbreken van de privé gegevens zullen wij de aanvraag NIET in behandeling nemen.

Tevens wijzen wij u erop dat bij eventuele wijziging van werkgever of privé adres, u verplicht bent dit door te geven.

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Ingevuld formulier via Faculteitsbestuur indienen bij:

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APPENDIX
INVENTION

April 9, 2008
Loe Feijs, Peter Peters, Frank Delbressine, Jun Hu TU/e

SENSOR AND SYSTEM FOR FLUID FLOW SIMULATION

PURPOSE

To simulate a umbilical cord or another assembly of veins and or arteries used for training of medical workers, training for first aid tasks in areas such as surgery, obstetrics and acute care paramedics. The invention simulates the effects and consequences of bending, blocking or otherwise obstructing the flow in a fluid channel such as typically but not exclusively the blood flow.

SUMMARY

The system contains a flexible tube the outside material and touch-related properties of which resemble the same of the real vessel that is being simulated. Those properties include the stiffness of the tube and its resistance against bending and twisting. The system sends an acoustical signal into the tube from one end and receives the same signal at the other end. If the tube is being squeezed, this will be detected by a weakening or absence of the acoustical signal. The system can easily be made to have a very natural look and feel without any real fluid flowing around. This precisely satisfies the need for simulation purposes in medical training. The system is very robust in the sense that its operation does not depend critically on material properties, tube length, sensor tuning etcetera. Moreover the system is insensitive to external noise because the receiver contains a band pass filter for the acoustic signal used and thus rejects other

frequencies. The system is cheap because all components are cheap, particularly the tube, the speaker, the microphone, the oscillator and the filter, none of which demand high precision components or fittings. The sender and the receiver need not be coupled, they each can run on their own power supply. They can be equipped with a message interface.

DESCRIPTION

As shown in *Figure A* the system contains a signal source (1) producing a sine wave of 1700 Hz the signal of which is fed into a miniature loudspeaker (2) which is enclosed in a small box of plastic or any other material. The box contains a hole in which a flexible plastic or rubber tube (3) fits such that the sound of the loudspeaker will be conveyed by the tube. These components together will be called the sender. At the other end of the tube is an assembly called receiver which consists of a microphone (4), an electronic or digital filter (5) and a detection unit (6). The filter is a band pass filter amplifying the 1700 Hz signal but weakening signals of very different frequencies. The detector consists of a rectifier with low-pass filter of time constant of 1 second such that the amplitude envelope of the signal is obtained. Said envelope signal goes to a comparison circuit with an adjustable threshold.

The frequency of 1700 Hz can equally well be higher or lower. Similarly the wave form can be a sine but other forms can be used as well. It is best to have a little bit of damping in the flexible tube, such as a soft material in one or two of the enclosing boxes or a well-chosen tube material, in order to prevent very sharp standing wave patterns. In our prototype, even without special measures we found the phenomenon of standing waves to cause no trouble at all.

The sender-tube-receiver system is part of a larger system which serves for purposes of medical training.

In one application shown in Figures B and C the flexible tube, perhaps together with other flexible tubes, forms a simulated umbilical cord connecting a mother manikin to a baby manikin. Of course the umbilical cord is connected to a kind of simulated placenta.

In *Figure B* item (1) is the said simulated placenta inside the simulated uterus (2) of the mother manikin, typically, but not exclusively, the sender. The other end, typically, but not exclusively, the receiver is connected to the baby manikin at the usual place of the belly button (3). The receiver is inside the baby manikin. The sender-tube-receiver subsystem will detect whether there is too much pressure on the umbilical cord, for example when it is squeezed between the baby and the delivery channel as shown in (4) or when there is a stretched twist (5) in the cord.

Figure C shows the larger system. The mother manikin (1) has an internal model (2), for example containing scripts, mathematical models, object-oriented models or any combination of those. Said model simulates bodily aspects of the mother, which may or may not be related to the blood flow simulated by the tube of the invention. Inside the mother manikin is a power supply (4) which feeds the sender (3). The baby manikin (5) contains its own power supply (6) which feeds the receiver and other equipment. The baby manikin has an internal model again being any combination of said modeling elements. The model controls output elements of the baby manikin, typically but not exclusively a simulated heart (9), a simulated skin color (10) or other bodily features (11). In a slightly different configuration the umbilical cord transports electric energy through the tube of the invention or any other tube so that either the mother or baby power supply becomes superfluous.

In another application shown in *Figure D* the flexible tube is inside a single manikin, for example, but not exclusively, a baby manikin. One or more of these tubes represent the arteries in the neck such that strangulation is detected by one or more instances of the sender-tube-receiver system of the invention. The sender is conveniently positioned in the head (1) of the manikin in which case the receiver is inside the torso (2). The tube is (3). A likely cause of strangulation is the umbilical cord (4) which may or may not be based on the invented sender-tube-receiver configuration.

The claim of this invention includes analog and digital generation and filtering. Figures E and F show the circuit diagrams of receiver and sender of one analog embodiment.

STATE OF THE ART

Dynamic childbirth simulators have been invented as early as 1974, see US3822486 *Dynamic childbirth simulator for teaching maternity patient* by Knapp et al. and the related US3797130, US3826019, US3824709. In US3822486 there is an umbilical cord and an amniotic sac but the cord only houses an electric conductor for a loudspeaker signal (no sound wave going through the cord).

More recent simulator-related inventions by Van Meurs et al. such as US6273728 *Life support simulation system simulating human physiological parameters,* are about the construction of manikins as a combination of a mathematical and a mechanical model. The idea of programmable behavior as such is already in the 1974 US3822486 but Van Meurs describes specific implementations. No special constructions of the umbilical cord are described in US6273728, let alone the acoustic sensor-tube-receiver system. Related inventions by the same authors are for example US5890908 *Apparatus for and method of simulating the injection and volatilizing of a volatile drug,* or US5772442 *Apparatus and method for simulating bronchial resistance or dilation,* none of which are either about the umbilical cord or other blood vessels simulated in the manner of the present invention.

Numerous inventions are done about the usage of sound waves and ultrasound waves for performing mechanical measurements such as measuring object positions or measuring existing flows in tubes. To the best of our knowledge none of these is about getting an indication about the status of a tube which is simulated as if it would be carrying a fluid flow for training purposes. For example: EP0292875 *Automatic device to indicate the horizontal position* or US4722224 *Ultrasonic sensor for the detection of gas bubbles*. The usage of ultrasound reflection is also well-known, but it should be noted that in the present invention neither ultrasound nor reflection play a role.

Road tubes are used for traffic monitoring and other vehicle detection systems. An example is the product Total traffic counter of Scottech, 89 Colombo Street, Frankton, Hamilton, New Zealand, see www.trafficcount.co.nz. Such road tubes work with an air sensor, measuring the pulse when a vehicle passes. Somewhat similarly but for a different application, US5096329 *Drunk driver detection system,* uses hollow strips containing pressure chambers, the volume of which is reduced when a vehicle tire crosses or rides along on top of one of the strips. US2007090931 *Pedestrian impact sensing apparatus for a vehicle bumper* uses a flexible hollow tube and measures airflow to know crush rate.

The present invention remotely resembles JP61256213 *Acoustic type edge sensor,* but the latter invention is about detecting internal contamination of a tube near the edge of a fitting only, not even about bending and twisting. Moreover the latter invention uses resonance, unlike the present invention. Note that the present invention does no rely on standing waves, reflections, resonance etc., although there may or may not be standing waves in the flexible tube. In our experience the detection mechanism is fairly robust for the presence of standing waves. The present invention also remotely resembles JP3279833 *Tube leakage detector,* but the latter

invention is about detecting leaks, whereas the present invention is primarily intended for bending twisting, squeezing etc, although it could be configured to detect leaks as well.

FIGURES

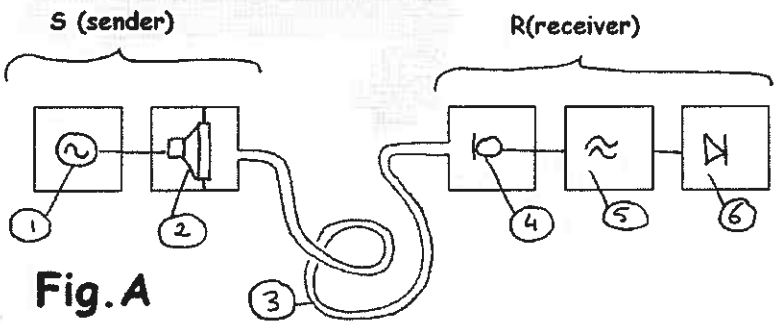

Fig.A

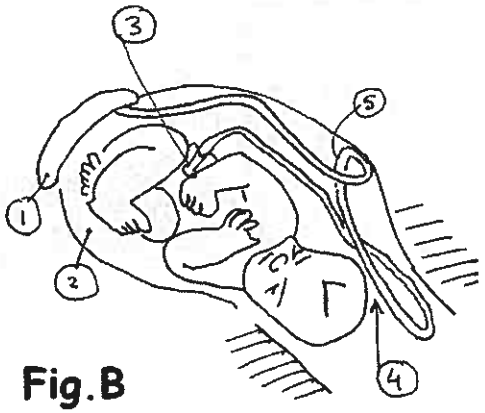

Fig.B

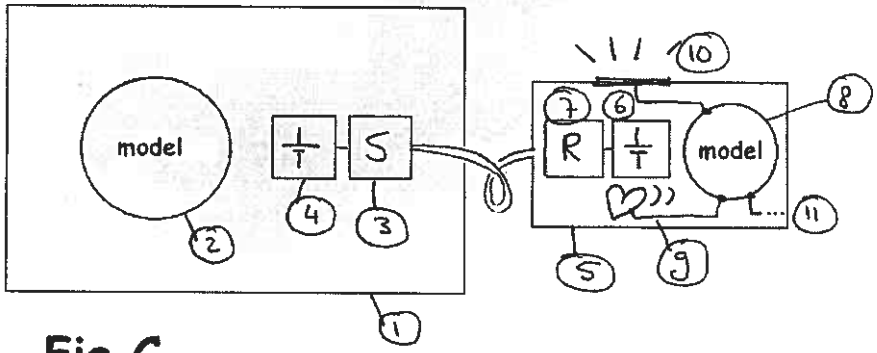

Fig.C

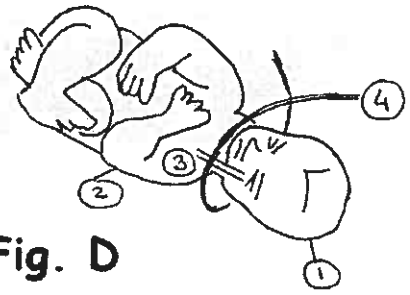

Fig. D

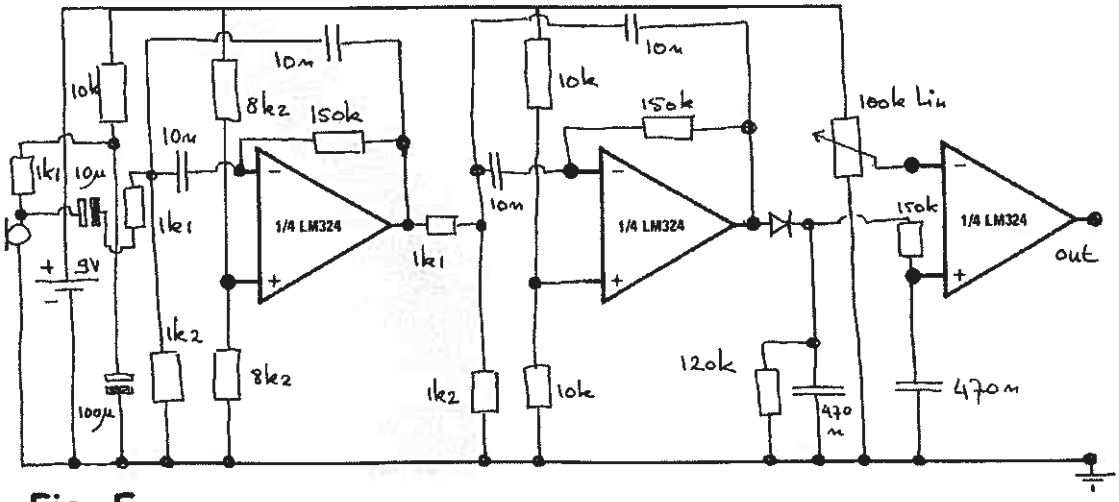

Fig. E

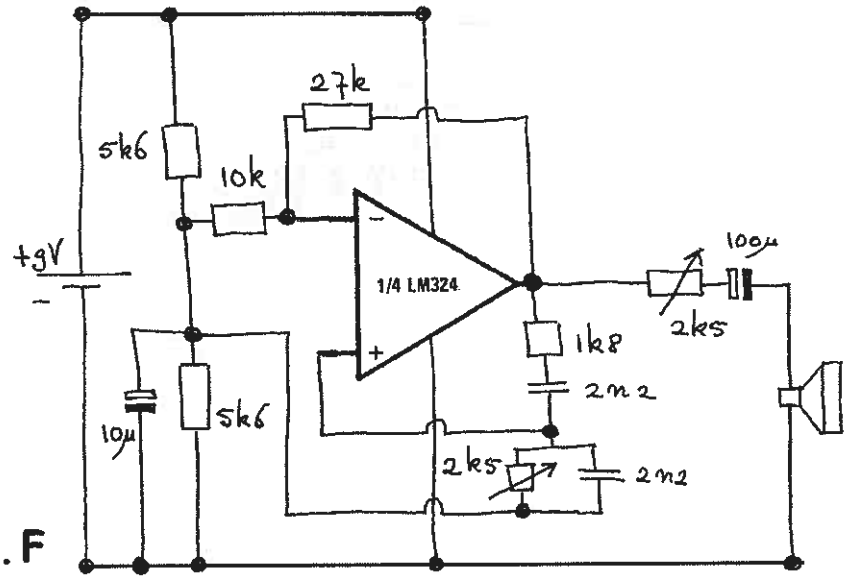

Fig. F