A system for measurement of direction related volumes, e.g. rooms in a building, is provided with an extractable measuring wire (12), the outer end of which can be moved to desired measuring points within the volume by means of a rod (20). A transducer (16) senses the length of the extracted wire, and two additional transducers (22, 26) sense the direction of the wire to the measuring point vertically and laterally. The output signals of the transducers are fed to a calculating circuit working the signals to a suitable form to achieve a dimensional drawing on a desired scale. For manual feeding of data related to the measuring point there is a portable keyboard unit (30) and in order to simplifying handling of the device the lower end of the rod (20) is attached to this unit (30). A gyro device (28) provides an outer reference so that measurements regarding different volumes can be related to each other. Thanks to the invention one person alone can perform accurate measurements without difficulty, e.g. of rooms in a building.
FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Austria</td>
<td>GA</td>
<td>Gabon</td>
<td>MR</td>
<td>Mauritania</td>
</tr>
<tr>
<td>AU</td>
<td>Australia</td>
<td>GB</td>
<td>United Kingdom</td>
<td>MW</td>
<td>Malawi</td>
</tr>
<tr>
<td>BB</td>
<td>Barbados</td>
<td>HU</td>
<td>Hungary</td>
<td>NL</td>
<td>Netherlands</td>
</tr>
<tr>
<td>BE</td>
<td>Belgium</td>
<td>IT</td>
<td>Italy</td>
<td>NO</td>
<td>Norway</td>
</tr>
<tr>
<td>BG</td>
<td>Bulgaria</td>
<td>JP</td>
<td>Japan</td>
<td>RO</td>
<td>Romania</td>
</tr>
<tr>
<td>BR</td>
<td>Brazil</td>
<td>KF</td>
<td>Democratic People's Republic of Korea</td>
<td>SD</td>
<td>Sudan</td>
</tr>
<tr>
<td>CF</td>
<td>Central African Republic</td>
<td>KK</td>
<td>Republic of Korea</td>
<td>SE</td>
<td>Sweden</td>
</tr>
<tr>
<td>CG</td>
<td>Congo</td>
<td>LI</td>
<td>Liechtenstein</td>
<td>SN</td>
<td>Senegal</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
<td>LX</td>
<td>Sri Lanka</td>
<td>SU</td>
<td>Soviet Union</td>
</tr>
<tr>
<td>CM</td>
<td>Cameroon</td>
<td>LU</td>
<td>Luxembourg</td>
<td>TD</td>
<td>Chad</td>
</tr>
<tr>
<td>DE</td>
<td>Germany, Federal Republic of</td>
<td>MC</td>
<td>Monaco</td>
<td>TG</td>
<td>Togo</td>
</tr>
<tr>
<td>DK</td>
<td>Denmark</td>
<td>MG</td>
<td>Madagascar</td>
<td>US</td>
<td>United States of America</td>
</tr>
<tr>
<td>FI</td>
<td>Finland</td>
<td>ML</td>
<td>Mali</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A system for measurement of direction related volumes

This invention relates to a system of the kind defined in the preamble of claim 1.

For height and direction related definitions of terrain, extension of streets, buildings etc., and other kind of height and values it is known to use theodolites, geodimeters, stereo-worked air photos etc. utilizing reference points in the net of triangulation of the country.

When measuring closed volumes of a limited size, such as flats and office premises, measurement is ordinarily carried out using measuring tapes. However, this is a time-consuming method which requires, in addition, a great number of checking measures. Nevertheless, the application of the method to a number of uniform spaces lying above each other show that the accuracy obtained is insufficient. Moreover, this method requires a lot of staff.

It is the object of this invention to enable one single person to carry out accurate measurements of closed volumes in a simple way, particularly when measuring existing buildings in connection with reconditioning and the like.

The aforesaid object is achieved according to the invention through an arrangement as claimed in the characterizing portion of claim 1.

The invention is described below in greater detail in the form of an illustrative example with reference to the appended drawing, wherein Fig. 1 illustrates schematically the mechanical principles of the measuring instrument and Fig. 2 illustrates the electrical buildup in the form of a block diagram.

As shown in Fig. 1 the measuring instrument is provided with a store 10 for an extractable measuring wire 12. The measuring wire is placed over a wheel 14 connected to a digital angle transducer 16, the emitted signal of which, thus, is a measure of the length of extracted wire. After the wheel 14 the measuring wire 12
passes a swivel arm 18 turning around a horizontal axis 17. The outer end of the wire is affixed to a rod 20 by means of which the user can move the wire end to the point desired within the volume to be measured.

The vertical angle of the swivel arm 18 is sensed by means of a digital angle transducer 22. The latter forms together with the arm 18, the angle transducer 16, the wheel 14 and the store 10 a unit turning about a vertical axis 24, the obtained horizontal angle of said unit being sensed by means of a digital angle transducer 26, which is preferably of the same type as the angle transducer 22. The angle transducers 22 and 26 should be of the high-resolution type while the transducer 16 measuring wire length, can be of the low-resolution type.

In order to form an external reference for the measurements, related to a known system of coordinates, the measuring instrument is provided with a gyro device 28 which can either be used for a correct orientation of the instrument at its set-up within the volume to be measured or is made to emit a signal responding to the deviation from a reference direction in order to relate the measuring values to this reference direction.

A portable keyboard unit 30 also belongs to the measuring instrument by means of which the user can enter different data relevant to the measurement, e.g. desired measuring moment, additional information of the measuring point (such as ceiling, floor, corner, pipe) or for denomination of the measured volume. To simplify handling the measuring rod 20 is preferably affixed to the unit 30.

The angle transducers 22 and 26, the wire length transducer 16 and the gyro device 28 are connected to a memory circuit 34 via respective matching circuits \(32_1-32_4\). The keyboard unit 30 is preferably via a wireless connection 36, e.g. a connection operating with ultrasonics or infra-red light, and a matching circuit 38 connected to the memory circuit 34. The output of the memory circuit 34 is connected to a calculating
circuit 40, e.g. a computer. The memory circuit 34 need not be separate but may be included in the calculating circuit 40. The matching circuits 32₁-32₄ and 38 preferably consist of conventional interfaces for adaptation of the output signals from the transducer and the keyboard to the circuits 34, 40.

When measuring a volume, e.g. a room in a flat, the instrument is thus set up within this volume, after which it is oriented relative to a known external system of coordinates by means of the gyro device 28 and is aligned in respect of a reference direction, e.g. true to the north. Alternatively, such an alignment need not be made but the calculating unit 40 may instead use the output signals of the gyro device to relate the measurements to the reference direction. Moreover, one measurement is performed against a known and previously determined point outside the room (e.g. the hall).

After this the user moves the end of the measuring rod 20 to each of the desired measuring points, the required length of the measuring wire thus being extracted from the store 10 under simultaneous turning of the unit consisting of the members 10, 14, 16, 22 and 18 about the axis 24 and adjustment of the height angle of the arm 18. The user indicates a desired measuring moment by depression of a suitable key on the unit 30, the data arriving at this time from the angle transducers 16, 22, 26 at the memory circuit 34 being stored therein. For each measuring point the user enters via the keyboard unit 30 also the necessary data for the additional information of the measuring point, i.e. data regarding ceiling, floor, corner etc., so that these data are also stored in the memory circuit. The denomination of the relative volume is preferably also entered.

In certain cases a desired measuring point may be hidden from the measuring instrument or otherwise be difficult to reach. The outer end of the measuring wire can then instead be moved to another point with a known relative position in respect of the desired measuring point, this relative position being simultaneously
entered via the keyboard unit 30. The calculating unit 40 will then calculate the actual position of the desired measuring point starting from these data.

The process described is repeated for all desired measuring points in the volume, after which the measuring instrument is moved to the next volume to be measured and the corresponding measurements are carried out for this volume.

As a consequence of the gyro device 28 measurements regarding different volumes will be related to an external, independent reference. Therefore the measuring method will not only allow measurement of each volume with a great accuracy but also that the different measured volumes will be carefully related to each other, which is of an obvious importance at measurement of a plurality of rooms in one and the same building.

In Fig. 2 the gyro device 28 is shown as connected with the memory circuit 34. If alignment of the measuring instrument is carried out with respect to the external reference for every volume measured, this connection can be omitted.

As mentioned, the memory circuit 34 can be an integral part of a computer containing the calculating circuit 40, but it can also form a separate memory unit, e.g. a magnetic tape unit which stores all the measuring values and data related to these and which is later connected to a suitable calculating circuit. The part of the measuring equipment, which must be portable and brought along by the user during the very measurement, is then simplified.

The calculating circuit 40 is preferable operative to emit output signals which allow a direct display of dimensioned drawings on a desired scale, either on a display unit or in the form of an printout.
Patent Claims

1. A system for measurement of direction related volumes, preferably rooms and similar spaces in a building, the system comprising, in a way known per se from other connections, a measuring instrument which can be placed in the room and is provided with a) an extractable measuring wire (12), intended to be moved with its outer end to the position of a desired point, b) a first means (16) for noting the length of extracted measuring wire, and c) a second and a third means (22, 26) for noting the vertical and horizontal directions respectively, of the extracted measuring wire (12) from the measuring instrument to the outer end of the wire, characterized in that the first, the second and the third means are transducers (16, 22, 26) for emitting the respective signals representing extracted measuring wire to the desired measuring point, or a point with a known position relative to the measuring point, and the directions of the measuring wire in vertical and horizontal direction from the measuring instrument, which signals are fed to a calculating circuit (40), preferable a computer, operative to form output signals on the basis of the output signals from the three transducers (16, 22, 26) and predetermined additional information of the correspondences of the measuring points with ceiling, roof, corner etc, and, where appropriate, the position of the measuring point relative to a point with a known position, said output signals being directly useful for display of a dimensional drawing related to the measured volume.

2. The system of claim 1, characterized in that a memory circuit (34) is operative for temporary storage of the output signals of the transducers, before these are added to the calculating circuit (40).

3. The system of claim 1 or 2, characterized in that the measuring instrument includes a gyro device (28) for relating the measurement of each separate volume to a fixed reference direction and a
known system of coordinates.

4. The system of claim 3, characterized in that the gyro device (28) is provided with a signal output for the supply of reference data to the calculating circuit (40).

5. The system of any one of the foregoing claims, characterized in that the outer end of the measuring wire (12) is affixed to one end of a rod (20) for moving this outer end to a desired measuring point.

6. The system of any one of the foregoing claims, characterized in that a preferably portable keyboard unit (30) is provided for manual feeding of data to the calculating circuit (40) regarding a desired measuring moment and said additional information of the measuring point.

7. The system of claims 5 and 6, characterized in that the other end of said rod (20) is affixed to the keyboard unit (30).
### I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC:

- G 01 F 17/00, G 01 B 21/00

### II. FIELDS SEARCHED

<table>
<thead>
<tr>
<th>Classification System</th>
<th>Classification Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPC 4</td>
<td>G 01 B 3/00, 5/00,03, 21/00,04; G 01 F 17/00</td>
</tr>
<tr>
<td>IPC 2</td>
<td>G 01 B 19/00</td>
</tr>
<tr>
<td>Nat Cl</td>
<td>42b:26/03; 42c:12; 42e:29</td>
</tr>
</tbody>
</table>

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:

SE, NO, DK, FI classes as above

### III. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of Document, &quot;A&quot; with indication, where appropriate, of the relevant passages</th>
<th>Relevant to Claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US, A, 2 068 822 (F SCHIESSER) 26 January 1937</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US, A, 2 632 952 (C MALLOW) 31 March 1953</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>EP, A2, 119 876 (SOURIAU &amp; CIE (S.A.)) 26 September 1984 See fig. 3</td>
<td>1</td>
</tr>
</tbody>
</table>

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "Z" document member of the same patent family

### IV. CERTIFICATION

- Date of the Actual Completion of the International Search: 1985-05-06
- Date of Mailing of this International Search Report: 1985-05-08
- Signature of Authorized Officer: Inge-Marie Josefsson

Form PCT/ISA/210 (second sheet) (January 1985)
### FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

<table>
<thead>
<tr>
<th>II</th>
<th>Fields searched (cont)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Cl</td>
<td>33:1</td>
</tr>
</tbody>
</table>

### V. OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE

This International search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claim numbers .........., because they relate to subject matter not required to be searched by this Authority, namely:

2. Claim numbers .........., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claim numbers .........., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 5.4(a).

### VI. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This International Searching Authority found multiple inventions in this international application as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- The additional search fees were accompanied by applicant's protest.
- No protest accompanied the payment of additional search fees.