(12) UK Patent Application (19) GB (11) 2 133 557 A

(21) Application No **8332008**
(22) Date of filing
30 Nov 1983
(30) Priority data
(31) **3615**
(32) **9 Dec 1982**
(33) **Italy (IT)**
(43) Application published
25 Jul 1984
(51) **INT CL³ G01L 5/10**
G05D 15/01
(52) Domestic classification
G1N 1A3A 1A3B 1D2A 1D2B 1F 1M3 4A 4C 7H2 AFC
A1P 3B
G3R A622 BH29
U1S 1005 1822 G1N G3R
(56) Documents cited
GB A 2093191
(58) Field of search
G1N

(71) Applicant
Fiat Trattori S p A
(Italy)
Via Pico della Mirandola
72
41100 Modena
Italy
(72) Inventor
Alfredo Cevolini
(74) Agent and/or Address for Service
Carpmaels & Ransford
43 Bloomsbury Square
London WC1A 2RA

(54) **Controlling agricultural tool attitude**

(57) A device for controlling the attitude of a tool adapted to be towed by an agricultural machine of the type comprising at least one arm connecting between the tool and a flexure bar fitted to the chassis of a machine and at least one lever connecting the arms to a control system which is characterized by including an electrical circuit which controls the movement of the lever by mechanical or hydraulic members. This circuit includes at least one resistive element 47 fixed to a central portion 51 of a pin 46 housed in an axial cavity 41 of a bar 3 and having end portions 48, 52 fixed in the cavity, so that the traction force on the tool causes the bar to deflect and cause extension or contraction of element(s) 47 whose electrical resistance is proportional to its deformation.

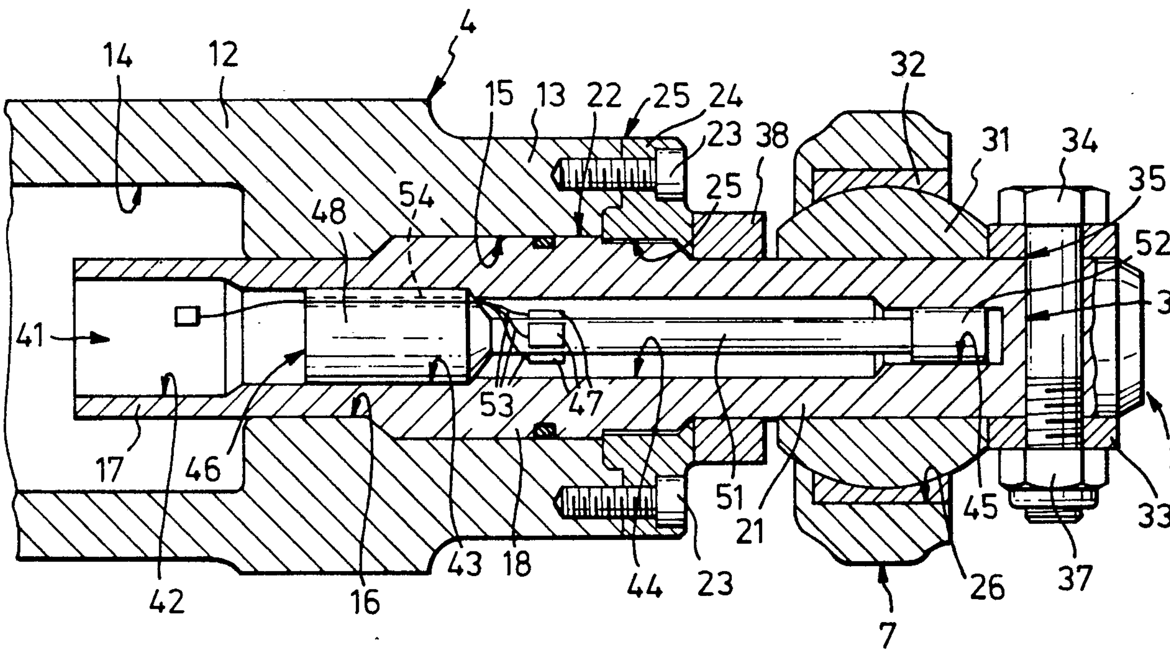
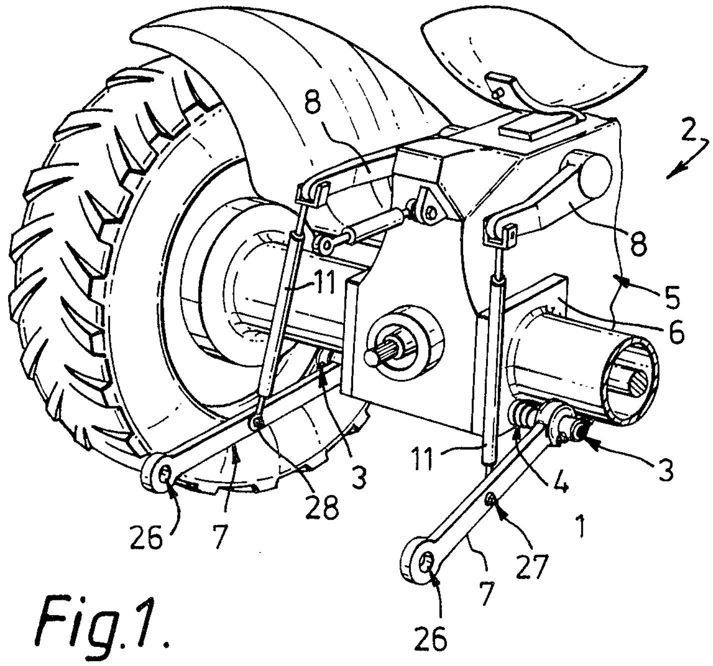


Fig.2.

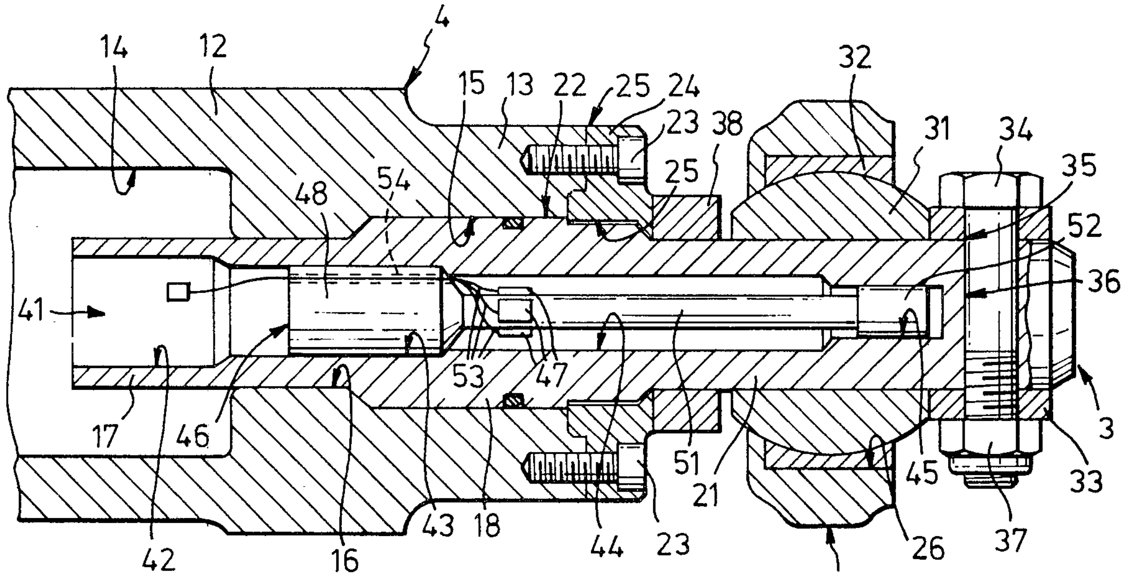
GB 2 133 557 A

The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.



8
2
8
5
6
11
11
3
3
4
28
3
1
26
7
27
7
26

Fig.1.



4
14
12
15
13
22
25
24
23
38
32
31
34
35
48
54
25
52
36
41
53
47
3
17
46
51
21
45
33
42
16
43
18
44
23
7
26
37

Fig.2.

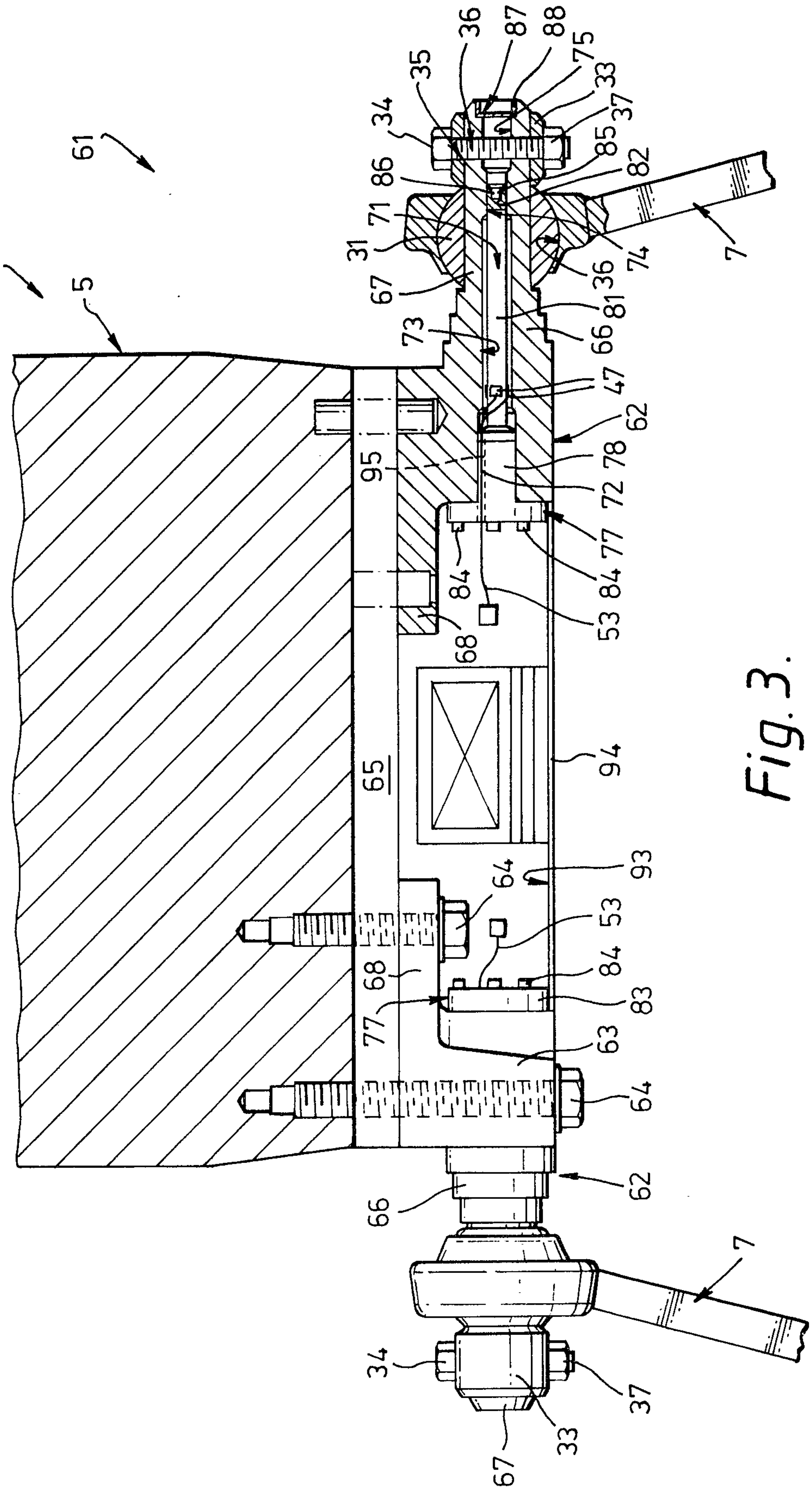

61
2
5
34
35
36
87
88
75
33
37
85
82
86
71
31
67
74
36
7
81
66
73
47
62
95
78
72
77
84
84
53
68
65
94
93
64
53
84
83
77
68
63
64
62
66
7
34
37
33
67

Fig. 3.

SPECIFICATION

A device for controlling the attitude of a tool adapted to be drawn by an agricultural machine

The present invention relates to a device for controlling the attitude of a tool adapted to be drawn by an agricultural machine.

As is known, such devices allow the force which acts on the tool attachment to be detected for the purpose of enabling automatic control of the attitude of the tool to be effected, which control in turn allows the performance of the agricultural machine to be optimised, and more particularly the power of the machine to be distributed in an optimum manner between its functions of towing or carrying the tool and positioning the tool itself at the required depth in the working track in the soil.

There are essentially three types of devices currently in use, classified in dependence on the member for detecting the flexure of a flexure bar. The first type of device includes a flexure bar mounted in the rear part of the agricultural machine and connected by two arms to the said tool. Under the action of the force applied by the tool in use the said bar deforms and this deformation is detected by a mechanical feeler of a mechanical member which transmits a displacement signal dependent on the deformation of the flexure bar, via a linkage, to a control system generally of hydraulic type. The control system is operable to control the raising or lowering of the tool and therefore to control the attitude in relation to the desired working depth, the quality of the soil and the power of the agricultural machine.

The second type of device utilises, in place of the said mechanical members, an electronic member which, via an electronic sensor determines the flexure of the flexure bar and sends a corresponding electrical signal to the said control system which therefore will have an electromechanical transducer.

The third type of device includes, in place of the said electrical or mechanical members, an electrical circuit which has a plurality of resistive elements fixed to a portion of the said flexure bar. These resistive elements are made of a material the electrical resistance of which is proportional to the extension or contraction of the element. This electrical circuit sends an electrical signal to the control system corresponding to the stretching or contraction of the resistive elements and which is therefore a function of the flexure of the flexure bar.

The devices described above have various serious disadvantages. In particular, devices of the first type, that is to say, those including mechanical members for detecting deformation of the flexure bar, have a limited sensitivity in that the said mechanical feelers of such mechanical members do not succeed in detecting small deformations of the flexure bar. Consequently the flexure bar, having to deform in a manner which can be sensed by the mechanical sensor, is subjected to a significant wear and therefore to avoid possible breakage it must be made from a suitably treated material which is therefore of high cost. Normally, relative sliding movements between the flexure bar and the chassis of the machine occur, which introduce errors into the detection. Moreover, such devices have a low speed of transmission of the displacement signal due to the mechanical flexibility of the linkage. Consequently, the said control system of such devices has a low response speed. Since the displacement signal is one detected by a mechanical member further difficulties are encountered for amplification of this signal without distortion. Finally, such devices are of high production cost due to the complexity of manufacture because of the necessary precision in the working of some of their components, because of the high quality of the materials which have to be used and because of the difficulty in heat treating the flexure bar.

Devices of the second type, that is those which include the said electronic member for detecting the deformations of the flexure bar, although having some advantages in terms, for example, of constructional simplicity and speed of response, are subject to several of the defects mentioned for the devices of the first type. Moreover, such devices involve a systematic and complex maintenance in that they are sensitive to ambient conditions, such as, for example, the presence of moisture and mud, in which the agricultural machine often has to work. Further, the said electronic members are sensitive to the vibrations and jerks of the agricultural machine and to the electromagnetic interference between the electronic member and the alternator. The electrical signal corresponding to the deformation is distorted by friction between the supports for the flexure bar and by the non-linearity thereof. Finally, with such devices it is not possible to obtain information on the different components of the force, that is to say, on those lying in a plane parallel to the direction of advancement of the tool and orthogonal to the axis of the flexure bar.

Devices of the third type, that is to say, extensible resistive elements, although being technologically more advanced with respect to devices of the first and second type, have several disadvantages due mainly to the introduction of the innovation constituted by the said extensible elements. In particular, such extensible elements are extremely delicate and therefore they must be provided with a protective system better than that currently used. Moreover, significant difficulties must be overcome for fitting the said elements onto the flexure bar in that this latter is heat treated (hardened) before assembly. The working stages for hardening the flexure bar are in contradiction to the deposition of the extensible elements, that is to say, with any kind of subsequent surface treatment which is exactly what is required for the deposition of extensible elements.

Relative sliding between the flexure bar and the supports causes the phenomenon of mechanical hysteresis and gives rise to a spurious electrical signal. Further, the assembly of the device is of high cost as, indeed, is the flexure bar due, above all, to its weight and the treatments to which it must be subjected. Finally, given the delicacy of the extensible elements and the longitudinal extension and weight of the bar, transport of the flexure bar during the various treatments and for assembly is complicated.

The object of the present invention is to provide a device for controlling the attitude of a tool adapted to be drawn by an agricultural machine, which will be free from the disadvantages mentioned above, which will be constructionally simple, easy to assemble and maintain, and of reduced production cost.

Further objects and advantages of the present invention will become apparent from the following description.

According to the present invention, there is provided a device for controlling the attitude of a tool adapted to be drawn by an agricultural machine, of the type comprising at least one connecting arm between the said tool and a flexure bar fixed to a chassis of the said machine, and at least one lever connecting the said arm to a control system, characterised by the fact that the said control system includes an electrical circuit operable to control the movement of the said lever by means of a mechanical and/or hydraulic member; the said electrical circuit includes at least one resistive element fixed to a central portion of a pin housed within an axial cavity in the said bar extending close to its opposite ends, the said pin having two end portions fixedly secured within the interior of the said cavity in such a way that in use the traction force on the said tool causes the said bar and therefore also the said central portion of the said pin to deflect which causes an extension or contraction of the said resistive element which is made of a material having an electrical resistance which is proportional to its deformations.

For a better understanding of the present invention, two preferred embodiments will now be described, purely by way of non limitative example, with reference to the attached drawings, in which:

Figure 1 is a perspective view of a device for controlling the attitude of a tool adapted to be drawn by an agricultural machine;

Figure 2 is a partial view in section of a detail of the device of Fig. 1; and

Figure 3 is a partially sectioned plan view of a different embodiment of the device of Fig. 1.

As illustrated in Fig. 1, a device for controlling the attitude of a tool (not illustrated) adapted to be drawn by an agricultural machine 2 is generally indicated with the reference numeral 1. The device 1 includes two cylindrical flexure bars 3 housed within a respective hollow cylindrical element 4 fixed at one end, for example by screws, onto a chassis 5 of the machine 2 which can be, for example, a transmission housing. In particular, the chassis 5 has two parallel side walls 6 from which the elements 4 project coaxially. It is to be noted that in devices currently on the market the flexure bar is a single piece whilst in this case, as will be seen better below, there is no reason to have a central part of the bar and therefore the flexure bars 3 represent the opposite end portions of the bar previously used. The device 1 further includes two lower arms 7 connecting the bars 3 to the said tool, a control system (not illustrated) operable to control the rotation of two upper arms 8 about a bar (not illustrated) mounted within the chassis 5 parallel to and above the bars 3, and two connecting levers 11 between the arms 7 and 8 pivotally connected, respectively, to the central part of the arm 7 and to the free end of the arm 8.

As illustrated in Fig. 2, the element 4 has an end portion (not illustrated) fixed to the chassis 5 on the interior thereof, a central portion 12 projecting from the chassis 5, and an end portion of smaller diameter than that of the portion 12. The cavity formed within the interior of the element 4 has a section 14 formed in correspondence with the central portion 12, a section 15 of small diameter than that of the section 14 and formed in correspondence with the end portion 13, and a section 16 connecting between the sections 14 and 15 and of smaller diameter than that of the section 15. The section 16 is formed in correspondence with the end of the central portion 12 connected to the portion 13. Each flexure bar 3 has an end portion 17 housed in sections 14 and 16, a central portion 18 of greater diameter than that of the portion 17 and lodged in the section 15, and an end portion 21 of diameter smaller than that of the portion 18 and projecting from the element 4. Between the central portion 18 and the end portion 21 the bar 3 has an intermediate portion 22 the diameter of which is intermediate between those of the portions 18 and 21. To the end portion 13 of the element 4 there is fixed, by means of screws 23, a cylindrical cover 24 having a central through hole 25 housing the intermediate portion 22 of the bar 3. The hole 25 of the cover 24 has a diameter slightly greater than that of the intermediate portion 22 in such a way as to allow a predetermined play to ensure that, in use, the bar 3 can deform without obstruction.

Each lower arm 7 has at each end a through hole 26 for the connection between the bar 3 and the tool, and a central through hole 27 engaged by a peg 28 on which is pivotally mounted a lower end of the lever 11. One hole 26 is engaged by the end portion 21 of the bar 3 by means of a ball joint 31 fitted onto the portion 21 itself, and a bush 32. To avoid possible disengagement of the end of the arm 7 from the bar 3 to the end portion 21 there is fixed a ring 33 forming a shoulder against the ball joint 31 held in place by a bolt 34 passing through a pair of diametral holes 35 and 36 formed respectively in the ring 33 and in the portion 21 and on the leg thereof projecting from the ring 33 there is screwed a nut 37. A spacer ring 38 is mounted on the end portion 21 of the bar 3 between the ball joint 31 and the cover 24.

As illustrated in Fig. 2, the flexure bar 3 has a cylindrical cavity 41 co-axial with the bar 3 itself and extending for the whole of the longitudinal extent of this latter, less that part of the end portion 21 where the ring 33 is mounted. The cavity 41 has a first section 42 formed in correspondence with the portion 17, a second section 43 of smaller diameter than that of the section 42 and formed between the portion 17 and the portion 18, a third section 44 of smaller diameter than that of the section 43 and formed in correspondence with a part of the portion 18, the portion 22, and a part of the portion 21, and a fourth section 45 of diameter smaller than that of the section 44 and formed in correspondence with a central part of the portion 21 subsequent to the section 44 and immediately before the solid end part of the portion 21.

With reference to Fig. 2, within the flexure bar 3 there is housed a pin 46 on which are fixed four extensible resistive elements 47 formed of a material having an electrical resistance which is proportional to the extension or contraction thereof. The pin 46 has an end portion 48 fixed by means of an adhesive within the interior of the section 43, a central portion 51 housed in the section 44 and of smaller diameter than that of this latter, and a second end portion 52, fixed by means of an adhesive to the interior of the section 45. The resistive elements 47 are supported by the end portion 13 of the element 4. Each resistive element 47 is connected by means of an electrical cable 53 to a pre-amplifier (not illustrated) normally housed in the section 42 of the bar 3. For this purpose the end portion 48 has through hole 54 housing the electrical cables 53 and the axis of which is parallel to that of the pin 46.

The resistive elements 47 are deposited on four respective planes in pairs parallel to one another in such a way as to detect, as will be seen better below, forces with components parallel to and orthogonal to the ground. The said control system includes an electrical circuit in which the resistive elements 47 are connected and a mechanical and/or hydraulic member operable, on the basis of the electrical signals coming from the said electrical circuit, to raise or lower the lower arms 7 and therefore the tool by means of the operation of the upper arms 8 and the levers 11. As already described, the resistive elements 47 are made from a material having the property of having an electrical resistance which is a function of the deformation to which the elements 47 are subjected in use. The elements 47 can be of metal wire, thick film or semiconductor type. Generally, the use of elements 47 of the metal wire type or semiconductor type is preferred because such materials are in current use and are therefore readily commercially available.

Thick film elements 47 are still in a development stage. These latter elements 47 are made with a paste based on glass and metal conductors, deposited and fired on a layer of binder material generally glass based. This layer permits a good adhesion without sliding of the elements 47 on the material, generally steel, with which the pin 46 is made. These elements 47 further have, for the connections with the electrical cables 53, connectors made of a noble metal. It is apparent that that part of the electrical circuit including the elements 47 can have various circuit arrangements such as, for example, the circuit arrangement known as a "Wheatstone bridge" or others. In the case of a flexural deformation of the bar 3 an extension (contraction) of one pair of elements 47 deposited on two parallel planes takes place whilst a contraction (extension) of the pair of elements 47 deposited on the other two parallel planes takes place; by using the "Wheatstone bridge" circuit arrangement the electrical potential becomes out of balance and this will represent the electrical signal sent to the pre-amplifier. This electrical signal will be proportional to the force applied by the tool on the flexure bar 3. The elements 47 deposited on orthogonal planes can form part of two separate circuit arrangements each of which will produce its own electrical signal. A processing of these electrical signals will permit the horizontal and vertical components of a force in any direction lying in a plane perpendicular to the axis of the flexure bar 3 to be detected.

The control system can be calibrated in such a way that for a force on the tool greater than a predetermined value (depending on the power of the machine 2) the electrical circuit including the elements 47 controls the raising of the tool by means of the said mechanical and/or hydraulic member.

In Fig. 3 there is generally indicated with the reference numeral 61 a device for the control of the attitude of a tool (not illustrated) adapted to be drawn by the agricultural machine 2. The device 61 differs from the device 1 described above only by the different conformation of the flexure bars and by the different manner in which these are fixed to the chassis 5. The device 61 includes two flexure bars 62 each of which has an end portion 63 of substantially prismatic form, or with at least one flat face by means of which it is fixed with the aid of screws 64 onto a rear wall 65 of the chassis 5, a cylindrical intermediate portion 66 having steps of decreasing diameter, and an end portion 67 on which one end of the lower arm 7 is pivoted by means of the ball joint 31. From the end portion 63 extends a plate 68 coplanar with the face of the portion 63 fixed to the chassis 5 and also fixed by screws 64 to this latter.

The flexure bar 62 has for the whole of its longitudinal extend a cylindrical cavity 71 coaxial with the portions 66 and 67. This cylindrical cavity 71 has, in succession, a first section 72 formed in correspondence with the portion 63, a second section 73 of smaller diameter than that of the section 72 and formed in correspondence with a part of the portion 63, the portion 66, and a part of the portion 67, a third section 74 of smaller diameter than that of the section 73, and a fourth section 75 the diameter of which is greater than that of the section 74 and formed in correspondence with that part of the portion 67 having the diametral hole 36 for housing the bolt 34 which clamps the ring 33 forming the shoulder against the ball joint 31. Within the cylindrical cavity 71 there is housed a pin 77 on which the said four resistive elements 47 are fixed in the same way as described for the device 1. The pin 77 has an end portion 78 housed in the section 72, a central portion 81 housed in the section 73, and an end portion 82 housed in the section 74.

Like the pin 46, the pin 77 must also have its end portions 78 and 82 fixed securely in the cavity 71. In this case, in place of a fixing by adhesive bonding agents, a mechanical fixing is preferred. The end portion 78 in fact has a cylindrical head 83 fixed to the portion 73 of the flexure bar 62 by means of a plurality of screws 84, whilst the end portion 82 has a cylindrical notch 85 in which, in use, a ball 86 is force fitted in such a way that the cylindrical surface of the portion 82 is pressed against the inner wall of the groove 71 thereby forming a secure fixing. At the outer end of the section 75 there is formed a seat 87 for a sealing plug 88.

With reference to Fig. 3, the diameter of the portion 81 of the pin 77 is less than that of the section 73. The resistive elements 47 are fixed on the portion 81 housed within the section 73 formed in the portion 63 of the bar 62. These resistive elements are connected by means of electrical cables 53 to the pre-amplifier (not illustrated) lodged in a chamber 93 defined by the wall 65 of the chassis 5, the portions 63 of the two bars 62, a rear closure plate 94 between the portions 63, and by upper and lower closure plates not illustrated. The portion 78 and its head 83 therefore have a hole 95 through which the electrical cables 53 can extend from the cavity 71 to be connected to the pre-amplifier. The same considerations as those applied to the resistive elements 47 of the device 1 also apply for the resistive elements 47 of the device 61, both as far as the materials and the manner of fixing are concerned, and as far as the circuit arrangement of the electronic circuit in which they are connected and the control system for control of the mechanical and/or hydraulic member are concerned.

The operation of the devices 1 and 61 is similar and both work in the following way.

In detail, when the lower arm 7 connected to the tool attachment transmits a component of the traction force to the bar 63 or 62, this deflects. This mechanical deformation is transmitted to the pins 46 or 77. Since these latter are rigidly fixed at their ends there will be flexure of their central portions 51 or 81. This flexure is transmitted to the resistive elements 47 which extend or contract in dependence on the position in which they are fixed on this central portion 51 or 81. It is therefore apparent that the elements 47 will cause an electrical signal in the electrical circuit in which they are connected proportional to the flexure of the pin 46 or 77 and therefore to the traction force applied by the tool to the bar 3 or 62. This signal, as already described, is processed by the control system which raises or lowers the tool by means of a mechanical and/or hydraulic member.

Numerous advantages are obtained by the system of the present invention.

In particular, these advantages can be divided into two sets, the first of which comprises the operating advantages and the second the advantages which are gained in the manufacture of the tool.

As far as the operation is concerned, it is apparent that the use of the resistive elements 47 permits even very small deflections of the pin 46 or 77 to be detected. Then, the fact that the pre-amplifier is located in close proximity to the elements 47 allows high amplification of the electrical signal produced by the electrical circuit including the elements 47 without appreciable distortion. Moreover, the pin 46 or 77, and in particular the central portions 51 or 81 are subjected exclusively to elastic movements while relative sliding movements or frictional movements with the bar 3 or 62 are entirely absent. The elastic movement which does take place therefore has a high linearity which permits a systematic proportionality between the traction force of the tool and deflection of the central portion 51 or 81 precisely because the absence of sliding movements or friction prevents the occurrence of mechanical hysteresis phenomena. The device 1 or 61 allows a high transmission speed of electrical information signals relating to the deflection of the pin 46 or 77 and therefore the magnitude of the traction force on the tool. Moreover, the possibility of depositing the elements 47 in even greater numbers on any plane permits the component of force in any direction to be determined. The position along the axis of the portion 51 or 81 of the elements 47 can be different in dependence on the electronic/mechanical sensitivity which it is decided to achieve.

As far as the manufacturing techniques are concerned, it is apparent that the separation of the force element (bar 3 or 62) from the sensor (pin 46 or 77) facilitates the construction of these elements and leaves considerable freedom in the choice of the resistive elements. In fact, the bars 3 or 62 are of smaller dimensions and weight with respect to those currently fitted and these bars 3 or 62, since they do not support any resistive elements 47, do not show the effects of such working steps as are necessary for the deposition of such elements 47 which currently compromise some characteristics of the bars. Moreover, the material from which the pin 46 or 77 is made need also not be expensive due to the fact that this pin 46 or 77 does not have to support the traction forces. The arrangement of the pin 46 or 77 in a sealed housing ensures that this latter is protected from the external environment, for example, from dust, aggressive chemical substances, moisture and mechanical shocks. Further, there is provided a seat for the pre-amplifier close to the position of the resistive elements 47 which permits, as well as the limitation of distortions of the electrical signal, also the possibility of not having unsupported electrical connection cables which are therefore subjected to damaging. The possibility of fixing the bar 62 directly to the chassis 5 simplifies the assembly of this latter. Finally, from what has been described above, it will be seen that the device 1 or 61 does not need systematic maintenance of the pin 46 or 77 and that even in the event of breakdown it is sufficient to mount a new pin and not a whole new bar as is currently the case. All this ensures that the device 1 or 61 is of lower manufacturing cost.

Finally, it is clear that the device 1 or 61 can be modified or varied without by this departing from the protective scope of the present invention.

In particular, the manner in which the end portions 48 and 52, or 78 and 82 of the pin 46 or 77 are fixed in the interior of the bar 3 or 62 can be different providing, however, that this fixing must be by securely fitting. Moreover, the manner of fixing of the bar 3 to the interior of the element 4 and the bar 62 to the chassis 5 can be different. Likewise, the conformation of the bar 3 or 62 and of the pin 46 or 77 can be different. For example, a single flexure bar could be used in which at the end there is formed a respective seat for the pin 46 or 77. The number of resistive elements 47 can be greater or less than that indicated and, likewise the position of these along the central portion 51 or 81 of the pin 46 or 77 can be different. Finally, the device 1 or 61 can include an electronic sensor operable to detect the position of the hydraulic elevating cylinder. This electronic sensor can be made using linear displacement transducers and rotary transducers of commercial type, or else by utilising a metal plate secured to a bracket the free end of which can receive a deflection imposed by a cam rigidly connected to the shaft which supports the upper arms 8. If resistive elements are deposited on the plate in close proximity to the fixing, an electrical signal can be produced from these in dependence on the flexural deformation of the plate itself. By utilising a central control unit it is possible to process the electrical signals coming from the pin 46 or 77 and the plate, that is to say, to process the information relating to the traction force and the position of the tool. The central control unit can include a comparator which compares this information with predeterminded lower and upper levels of the force and position to activate the mechanical and/or hydraulic member operating to control the lowering or raising of the tool and to protect the various parts of the device 1 or 61.

CLAIMS

1. A device for controlling the attitude of a tool adapted to be drawn by an agricultural machine, of the type comprising at least one arm connecting between the said tool and a flexure bar fixed to a chassis of the said machine, and at least one lever connecting the said arms to a control system, characterised by the fact that the said control system includes an electrical circuit operable to control the movement of the said lever by means of mechanical and/or hydraulic members; the said electrical circuit includes at least one resistive element fixed to a central portion of a pin housed within an axial cavity in the said bar extending close to its opposite ends, the said pin having two end portions securely fixed within the interior of the said cavity in such a way that in use the traction force on the said tool causes the said bar and therefore also the said central portion of the said pin to deflect and cause an extension or contraction of the said resistive element which is made of

a material the electrical resistance of which is proportional to its deformation.

2. A device according to claim 1, characterised by the fact that the said flexure bar is made in two co-axial parts fixed to opposite side walls or else to opposite ends of a rear wall of the said chassis.

3. A device according to claim 2, characterised by the fact that each part of the said flexure bar has a first cylindrical end portion on which one end of the said arm is pivotally mounted, a cylindrical portion of diameter greater than that of the said first cylindrical portion and a second end portion fixed to the said chassis.

4. A device according to claim 3, characterised by the fact that the said second end portion is cylindrical and housed in a hollow element fixed to the said side walls of the said chassis.

5. A device according to claim 3 characterised by the fact that the said second end portion is substantially prismatic and has a flat face fixed to one end of the said rear wall of the said chassis.

6. A device according to at least one of the preceding claims, characterised by the fact that the said pin is cylindrical and the said central portion of this latter is of smaller diameter than that of the said end portions thereof.

7. A device according to claim 6, characterised by the fact that the fixing of the said end portions of the said pin to the interior of the said cavity is effected by an adhesive.

8. A device according to claim 6, characterised by the fact that the fixing of the said end portions of the said pin to the interior of the said cavity is effected by means of mechanical locking: for example, one of the said end portions of the said pin has a head projecting from the said cavity and fixed by means of a plurality of screws to the said second end portion of the said bar and the other has a recess in which in use there is housed a ball in such a way that its outer surface is pressed by the said ball against the inner surface of the section of the said cavity.

9. A device according to at least one of the preceding claims, characterised by the fact that on the said central portion of the said pin it is possible to deposit one or more of the said resistive elements with these being positioned in pairs of parallel planes.

10. A device according to claim 9, characterised by the fact that the said resistive elements are connected to the said electrical circuit by means of a respective cable projecting from the said cavity through a hole extending along one of the said end portions of the said pin housed in correspondence with the said second end portion of the said bar.

11. A device according to at least one of the claims from 3 to 10, characterised by the fact that the said resistive elements are deposited on the said central portion of the said pin in correspondence with the said cylindrical central portion of the said bar.

12. A device according to at least one of the preceding Claims, characterised by the fact that within the said cavity there is formed a housing for an amplifier connected to the said resistive elements.

13. A device according to at least one of Claims 2, 3 and 5 to 11, characterised by the fact that between the said second end portions of the said bar there is formed a chamber to accommodate an amplifier for each of the said bars.

14. A device according to at least one of the preceding Claims, characterised by the fact that the said resistive element is of the metal wire type or thick film type or semiconductor type.

15. A device according to at least one of the preceding Claims, characterised by the fact that it includes a sensor operable to detect the position of the tool with respect to the said machine.

16. A device for controlling the attitude of a tool adapted to be drawn by an agricultural machine, as described and illustrated with reference to the attached drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1984.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.