

PATENT SPECIFICATION

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(54) PRINTING DEVICE

(71) We, KABUSHIKI KAISHA SUWA SEIKOSHA and SHINSHU SEIKI KABUSHIKI KAISHA, both Japanese companies, of 3-4, 4-chome, Ginza, Chuo-ku, Tokyo, Japan and 3-5, 3-chome, Owa, Suwashi, Nagano-ken, Japan, respectively, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to printing devices. Recently, ultra-compact electronic desk calculators have been produced using LSI electronic circuitry and light emitting diodes or liquid crystal display elements. This type of construction has enabled the miniaturisation and reduction in the power consumption of electronic desk calculators.

However, miniaturisation and reduction of the power consumption of electronic desk calculators having a printing device is more difficult because it has been found difficult to miniaturise and reduce the power consumption of the printing device, the printing device and an associated power source circuit taking up a relatively large space. Thus, there is a need in industry for a miniaturised printing device having a relatively low power consumption.

The present invention seeks to satisfy this need.

According to the present invention there is provided a printing device including at least one print character carrying member having a plurality of print characters on the peripheral surface thereof, a pressure roller which, during a printing operation, presses against a desired print character or characters located at a printing position, and a cradle upon which said pressure roller is rotatably mounted, the cradle defining a recess within which the pressure roller is partially disposed the axis of rotation of the cradle being spaced apart from the axis of rotation of the pressure roller, the cradle having journal means about which it can rotate, the radius of the pressure roller being greater than the difference between the radius of the journal means and the distance

between the radius of the journal means and the distance between the rotational axis of the cradle and the rotational axis of the pressure roller. Said pressure roller may comprise a shaft and at least one annular pressure member arranged to press against the desired character or characters, said at least one annular pressure member being resiliently supported from the shaft.

In one embodiment there are a plurality of print character carrying members and a plurality of annular pressure members, each annular pressure member being aligned with a respective print character carrying member. A resilient member may be disposed between the shaft and the annular pressure members, a groove being provided in the resilient member between adjacent annular pressure members. The annular pressure members may be made of a harder material than the material of which the resilient member is made.

In another embodiment there is a printing device as claimed in claim 3 in which there is a single annular pressure member or a resilient layer being disposed between the shaft and the annular pressure member which is made of a harder material than the material of which the resilient layer is made.

The pressure roller is preferably elongate having a length in excess of its diameter.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1, consisting of Figure 1(a) and 1(b) is a sectional view and a plan view respectively of one embodiment of a conventional printing device;

Figure 2; consisting of Figure 2(a), Figure 2(ab), Figure 2(c) and Figure 2(d), illustrates a printing device according to the present invention, Figure 2(a) being a sectional view thereof, Figure 2(b) being a sectional plan view of a support member and a pressure roller thereof, Figure 2(c) being an enlarged perspective view of part of the support member and pressure roller, and Figure 2(d) being an enlarged perspective view of a retaining ring thereof;

Figure 3, consisting of Figure 3(a) and 3(b)

is a sectional view of two modified pressure rollers for the printing device of Figure 2;

Figure 4 is a sectional view of another modification of the pressure roller of the printing device of Figure 2;

Figure 5 is a sectional view of a yet further modification of the pressure roller of the printing device of Figure 2;

Figure 6 is a sectional view of another modification of the pressure roller of the printing device of Figure 2; and

Figure 7 is an explanatory diagram illustrating the principle of operation of the printing device of Figure 2.

A conventional printing device, disclosed in U.S. Patent Specification No. 3,381,790, is shown schematically in Figure 1. This conventional printing device comprises a plurality of print character rings 2 mounted side by side on a shaft 1, there being one print character ring for each column to be printed. Each print character ring 2 carries a plurality of print characters 3. During a printing operation, which will be explained in relation to one of the print character rings 2, a desired print character on the print character ring is brought to a printing position by rotating the shaft 1. A pressure disc 5 supporting platen roll 4 mounted on a shaft 6, is then rotated so that the platen roll 4 presses print paper 8 against the desired print character, an inked ribbon 9 being disposed therebetween. During this printing operation a resilient part 7 of the pressure disc 5 is elastically deformed as it is engaged by the platen roll 4.

In this conventional printing device there is a relatively large distance between the axis of the shaft 6 and the axis of the platen roll 4. Thus the load torque on the shaft 6, during the printing operation is relatively large because the load torque is proportional to this distance. Further, as the load torque on the shaft 6 is relatively large, a motor and a power transmitting portion (not shown), of the conventional printing device must be made of relatively large size. Consequently, it is difficult to miniaturise and to reduce the power consumption of the conventional printing device.

During the printing operation, the platen roll 4 is urged towards the axis of the shaft 6 against the action of the resilient part 7 of the pressure disc 5. The spring constant of the resilient part 7 is much larger in the radial direction relative to the pressure disc 5 than the spring constant in the circumferential direction. Consequently, when the platen roll 4 reaches the desired print character 3 during the printing operation, the resilient part 7 of the pressure disc 5 is deformed more in the circumferential direction than in the radial direction. The platen roll 4 thus stops for a moment when it reaches the desired print character and, when the resilient part 7 of the pressure disc 5 has been

deformed sufficiently, the platen roll moves over the desired print character so that the print paper 8 and the inked ribbon 9 are pressed thereagainst. When the platen roll 4 moves over the desired print character it will have an angular velocity which is greater than the angular velocity of the pressure disc 5 by virtue of the deformation in the circumferential direction of the resilient part 7 of the pressure disc 5. Accordingly, the resulting printed character on paper is difficult to read especially because the portion printed when the platen roll had just reached the desired print character is dark whilst the remaining portion is fainter.

In the conventional printing device, because the radius of the pressure disc is greater than its axial length, and because of machining tolerances during manufacture of the pressure disc, the pressure disc tends to be inclined at an angle to the axial direction, so that the sides of the printed character are uneven, one side being darker than the other. Further, since a pressure disc 5 and a platen roll 4 are required for each print character ring 2 or each column to be printed, each column printed is uneven for the above reasons. Moreover, manufacture of the pressure disc is difficult because its of a somewhat complicated shape and each pressure disc must be secured on the shaft 6 in exact alignment with the respective print character ring.

Therefore, it will be appreciated that the conventional printing device is of complicated construction and has a relatively large number of parts. Consequently, there is a relatively large number of steps involved during assembly, creating a relatively high cost.

A printing device according to the present invention is illustrated in Figure 2 which consists of Figure 2(a), Figure 2(b), Figure 2(c) and Figure 2(d).

A plurality of print character carrying members 22 are mounted side by side upon a shaft 21, there being one print character carrying member for each column to be printed. A plurality of print characters are disposed on the periphery of each print character carrying member 22. During a printing operation, which will be explained in relation to one print character carrying member, a desired print character on the print character carrying member 22 is brought to a printing position by rotating the shaft 21. When in the printing position, the desired print character faces a rotatably mounted cradle 26 in which an axially extending pressure roller 24 is rotatably mounted. The pressure roller 24, made of resilient material such as rubber or plastics material, is secured to a shaft 25. The cradle 26 has a recess 30 in which the pressure roller 24 is partially disposed. The radius of the pressure rollers 24 is greater than the difference between the radius of journal portions 27 of the support

member 26 and the distance between the rotational axis of the journal portions 27 and the rotational axis of the pressure roller 24. By this arrangement the load torque on the journal portions 21 during the printing operation can be reduced, and the printing device can be miniaturised.

When the cradle 26 is rotated about the journal portions 27 from a rest position, the pressure roller 24, secured to the shaft 25, also rotates about the journal portions 27. When the printing operation is performed, the pressure roller is elastically deformed so that print paper 28 is pressed against the desired print character 23 at the printing position, an inked ribbon 29 being disposed therebetween, thus resulting in a printed character on the print paper. The pressure roller 24 is then returned to the rest position with the cradle 26 and the printing operation is then complete.

For ease of assembly and disassembly for repair, support member 26 has a pair of oppositely disposed recesses 31 in which the ends of the shaft 25 of the pressure roller 24 are supported. Further, in order to prevent the shaft 25 from being unintentionally disengaged from the recesses 31, a split, resilient retaining ring 33 is resiliently mounted in a groove 32 provided in the outer periphery of the cradle 26.

It will be appreciated that the above described printing device is of relatively low cost and a highly reliable because it is of simple construction, having a relatively small number of parts. Further the printing device can be assembled and disassembled for repair with relative ease and with relatively few steps.

An explanation as to how the load torque on the journals 27 during the printing operation is reduced will be explained with reference to Figure 7. In Figure 7, the rotational axis of the cradle 26 is indicated at O_1 and the rotational axis of the print character carrying member is indicated at O_2 . The distance between the rotational axis of the cradle 26 and the rotational axis of the pressure roller 24 is l , the radius of the pressure roller being R . The radius of the journals of the shaft 25 is r . The angle subtended by the desired print character 23 to the rotational axis O_1 of the cradle 26 is θ . Thus the energy required to move pressure roller moves from the point C_1 to the point C_2 is given by the expression:

$$(1) \quad T\theta = \mu Fr \left(2 + \frac{l}{R} \right) \theta = Eh$$

where: F is the pressure applied by the pressure roller on the desired print character;

T is the load torque about the rotational axis O_1 of the support member 26;

μ is the coefficient of friction between the shaft 25 and the support member; and

Eh is the energy required to deform the pressure roller as it moves over the surface of the desired print character. Frictional losses due to rotation of the cradle are ignored as being insignificant. From expression (1) the following relationship can be obtained:

$$(2) \quad T = \mu Fr \left(2 + \frac{l}{R} \right) + \frac{Eh}{\theta} \quad 70$$

μFr are fixed by the printing quality required.

$$\frac{Eh}{\theta}$$

is the energy required to deform the pressure roller per unit angle of rotation and again is fixed. Further, in the case where the dimension $R+l$ is fixed, in order to make the load torque T relatively small, it is sufficient merely to make l relatively small and R relatively large. As will be appreciated, it is possible with a printing device according to the present invention to make l sufficiently small or to make R sufficiently large so that the load torque T during the printing operation is maintained at an acceptable small level.

In the case of the conventional printing device described above with reference to Figure 1, it is clearly difficult to make the distance between the axis of the pressure disc 5 and the axis of the platen roll 4 small for structural reasons and consequently, it is very difficult to make the load torque small because as the radius of the platen roll increases the difference between the axis of the pressure disc and the axis of the platen roll also increases.

In the present invention the printing device can be miniaturised and the load torque on the journals 27 can be reduced because l can be made relatively small, so that $l+R$ is relatively small. Further, since the load torque during the printing operation can be reduced, a motor and a power transmitting mechanism (not shown) required to drive the printing device can be made compact and consequently the power consumption of the printing device can be reduced. Further, since it is unnecessary to provide the pressure disc of the conventional printing device, the rolling speed of the cradle 26 is fixed during the printing operation and since the pressure roller is not inclined to its axis, there is little unevenness in printing pressure and so good quality printing is obtainable.

Two modifications of the pressure roller of the printing device of Figure 2 are illustrated in Figure 3. As shown in Figure 3(a) the pressure roller has an annular pressure member 43. As shown in Figure 3(b) the pressure

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roller has a plurality of axially spaced apart annular pressure members 43 each aligned with a respective print character carrying member. The or each pressure member 43 is made of, for example, rubber, plastics material or metal. Between the pressure member or pressure members 43 and a shaft 41 is a resilient member 42 made, for example, of rubber or plastics material. The pressure member or pressure members 43 are made of a material harder than the material of the resilient member 42. When a pressure roller of this construction engages a desired print character with the print paper and the inked ribbon disposed therebetween, the resilient member 42 is deformed, but the pressure member or pressure members 43 are only slightly deformed so that the pressure member or pressure members are almost flat and almost in line contact with the surface of the desired print character. Consequently, good and clean quality printing can be obtained.

Figure 4 illustrates a further modification of the pressure roller of the printing device of Figure 2. The pressure roller consists of an annular pressure member 53 covered with a layer 54 of resilient material. A resilient member 52 is disposed between the pressure member 53 and a shaft 51. The pressure member 53 may be unitary as shown or in a plurality of sections, each section being aligned with a print character carrying member. The resilient member 52 and the layer 54 together with the pressure member 53 are all made, for example, of rubber or plastics material. The pressure member 53 is, however, constructed of a material which is harder than the material of the resilient member 52 or the layer 54. This construction of the pressure roller has the same advantages as the pressure roller of Figure 3 and also the advantage that the layer 54 deforms to the surface of the desired, print character in spite of the fact that this surface is somewhat uneven. Consequently, improved print quality can be obtained.

Figure 5 illustrates yet another modification of the pressure roller of the printing device of Figure 2. The pressure roller of this embodiment has a peripheral pressure portion 63. An elastically deformable portion 62 is disposed between the pressure portion 63 and a shaft 61. Again, with a pressure roller of this construction, good quality printing can be obtained.

Another modification of the pressure roller of the printing device of Figure 2 is illustrated in Figure 6. This pressure roller has a pressure member 73 made, for example, of rubber or plastics material. A resilient member 72 also made, for example, of rubber or plastics material, is disposed between the pressure member 73 and a shaft 71. The pressure member 73 may be unitary or in sections as shown, each section being aligned with one of

the print character carrying member. In the case where the pressure member 73 is in sections, it may be made of a material which is harder than the material of the resilient member 72. The resilient member 72 has a plurality of grooves 74 in the periphery thereof corresponding to the areas between each section of the pressure member 73. This embodiment of the pressure roller has the same advantages as the pressure roller illustrated in Figure 3 and, in addition, the advantage that, when the resilient member 72 is deformed during a printing operation this does not exert an influence upon other columns by virtue of the grooves 74. Thus different shades of printing is eliminated and so very good quality printing can be obtained.

As will be appreciated from the above discussion, it is possible to provide a compact, lightweight and low priced printing device having a relatively high reliability wherein the load torque during the printing operation is reduced. The structure of the printing device is relatively simple and consists of a small number of parts, assembly being easy and good print quality being obtainable. The printing devices described above are also relatively quiet during operation.

WHAT WE CLAIM IS:—

1. A printing device including at least one print character carrying member having a plurality of print characters on the peripheral surface thereof, a pressure roller which, during a printing operation, presses against a desired print character or characters located at a printing position, and a rotatably mounted cradle upon which said pressure roller is rotatably mounted, the cradle defining a recess within which the pressure roller is partially disposed the axis of rotation of the cradle being spaced apart from the axis of rotation of the pressure roller, the cradle having journal means about which it can rotate, the radius of the pressure roller being greater than the difference between the radius of the journal means and the distance between the rotational axis of the cradle and the rotational axis of the pressure roller.

2. A printing device as claimed in claim 1 in which said pressure roller comprising a shaft and at least one annular pressure member arranged to press against the desired character or characters, said at least one annular pressure member being resiliently supported from the shaft.

3. A printing device as claimed in claim 2 in which there are a plurality of print character carrying members and a plurality of annular pressure members, each annular pressure member being aligned with a respective print character carrying member.

4. A printing device as claimed in claim 3 in which a resilient member is disposed between the shaft and the annular pressure

roller has a plurality of axially spaced apart annular pressure members 43 each aligned with a respective print character carrying member. The or each pressure member 43 is made of, for example, rubber, plastics material or metal. Between the pressure member or pressure members 43 and a shaft 41 is a resilient member 42 made, for example, of rubber or plastics material. The pressure member or pressure members 43 are made of a material harder than the material of the resilient member 42. When a pressure roller of this construction engages a desired print character with the print paper and the inked ribbon disposed therebetween, the resilient member 42 is deformed, but the pressure member or pressure members 43 are only slightly deformed so that the pressure member or pressure members are almost flat and almost in line contact with the surface of the desired print character. Consequently, good and clean quality printing can be obtained.

Figure 4 illustrates a further modification of the pressure roller of the printing device of Figure 2. The pressure roller consists of an annular pressure member 53 covered with a layer 54 of resilient material. A resilient member 52 is disposed between the pressure member 53 and a shaft 51. The pressure member 53 may be unitary as shown or in a plurality of sections, each section being aligned with a print character carrying member. The resilient member 52 and the layer 54 together with the pressure member 53 are all made, for example, of rubber or plastics material. The pressure member 53 is, however, constructed of a material which is harder than the material of the resilient member 52 or the layer 54. This construction of the pressure roller has the same advantages as the pressure roller of Figure 3 and also the advantage that the layer 54 deforms to the surface of the desired, print character in spite of the fact that this surface is somewhat uneven. Consequently, improved print quality can be obtained.

Figure 5 illustrates yet another modification of the pressure roller of the printing device of Figure 2. The pressure roller of this embodiment has a peripheral pressure portion 63. An elastically deformable portion 62 is disposed between the pressure portion 63 and a shaft 61. Again, with a pressure roller of this construction, good quality printing can be obtained.

Another modification of the pressure roller of the printing device of Figure 2 is illustrated in Figure 6. This pressure roller has a pressure member 73 made, for example, of rubber or plastics material. A resilient member 72 also made, for example, of rubber or plastics material, is disposed between the pressure member 73 and a shaft 71. The pressure member 73 may be unitary or in sections as shown, each section being aligned with one of

the print character carrying member. In the case where the pressure member 73 is in sections, it may be made of a material which is harder than the material of the resilient member 72. The resilient member 72 has a plurality of grooves 74 in the periphery thereof corresponding to the areas between each section of the pressure member 73. This embodiment of the pressure roller has the same advantages as the pressure roller illustrated in Figure 3 and, in addition, the advantage that, when the resilient member 72 is deformed during a printing operation this does not exert an influence upon other columns by virtue of the grooves 74. Thus different shades of printing is eliminated and so very good quality printing can be obtained.

As will be appreciated from the above discussion, it is possible to provide a compact, lightweight and low priced printing device having a relatively high reliability wherein the load torque during the printing operation is reduced. The structure of the printing device is relatively simple and consists of a small number of parts, assembly being easy and good print quality being obtainable. The printing devices described above are also relatively quiet during operation.

WHAT WE CLAIM IS:—

1. A printing device including at least one print character carrying member having a plurality of print characters on the peripheral surface thereof, a pressure roller which, during a printing operation, presses against a desired print character or characters located at a printing position, and a rotatably mounted cradle upon which said pressure roller is rotatably mounted, the cradle defining a recess within which the pressure roller is partially disposed the axis of rotation of the cradle being spaced apart from the axis of rotation of the pressure roller, the cradle having journal means about which it can rotate, the radius of the pressure roller being greater than the difference between the radius of the journal means and the distance between the rotational axis of the cradle and the rotational axis of the pressure roller.

2. A printing device as claimed in claim 1 in which said pressure roller comprising a shaft and at least one annular pressure member arranged to press against the desired character or characters, said at least one annular pressure member being resiliently supported from the shaft.

3. A printing device as claimed in claim 2 in which there are a plurality of print character carrying members and a plurality of annular pressure members, each annular pressure member being aligned with a respective print character carrying member.

4. A printing device as claimed in claim 3 in which a resilient member is disposed between the shaft and the annular pressure



members, a groove being provided in the resilient member between adjacent annular pressure members.

5 5. A printing device as claimed in claim 4 in which the annular pressure members are made of a harder material than the material of which the resilient member is made.

10 6. A printing device as claimed in claim 2 in which there is a single annular pressure member or a resilient layer being disposed between the shaft and the annular pressure member which is made of a harder material than the material of which the resilient layer is made.

7. A printing device as claimed in any 15 preceding claim in which the pressure roller is elongate having a length in excess of its diameter.

8. A printing device substantially as herein 20 described and shown in Figure 2 or Figure 2 as modified by any of Figures 3 to 6 of the accompanying drawings.

J. MILLER & COMPANY,
Chartered Patent Agents,
262 High Holborn,
London, WC1V 7EF,
Agents for the Applicants.

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