May 21, 1968 L. C. THAYER 3,384,216

RESILIENTLY MOUNTED FONT WHEEL

Filed Dec. 5, 1966 2 Sheets-Sheet 1

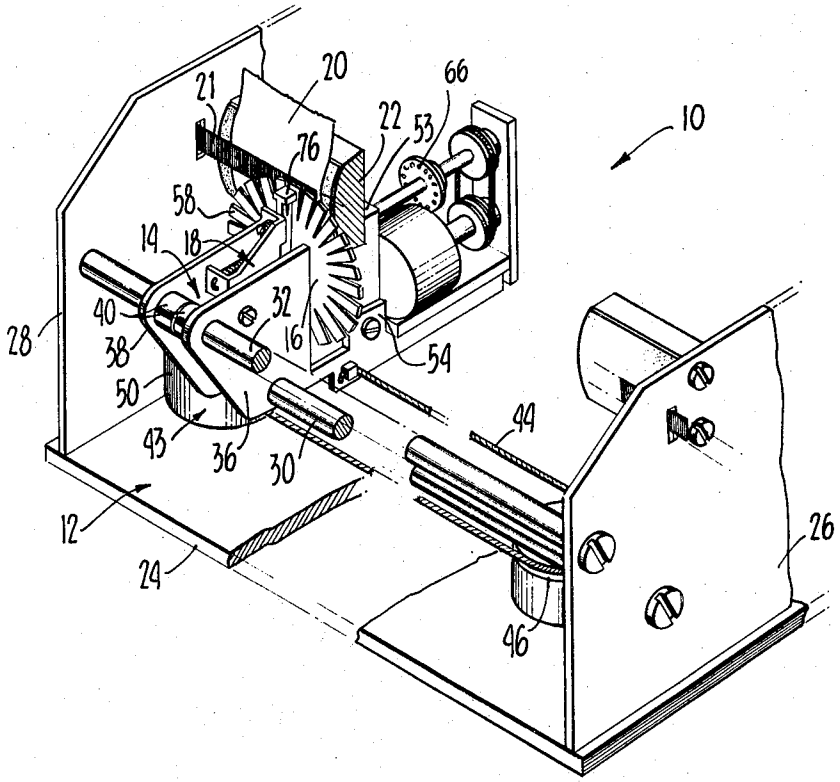

FIG_1

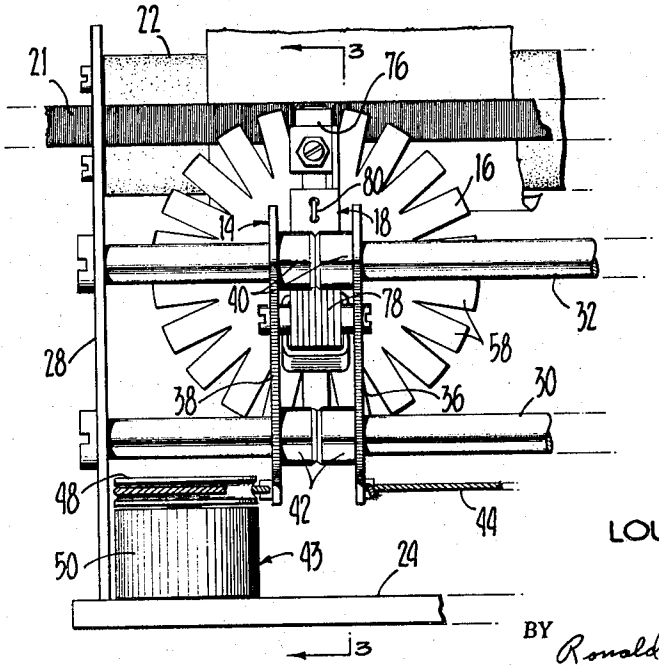

FIG_2

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RESILIENTLY MOUNTED FONT WHEEL

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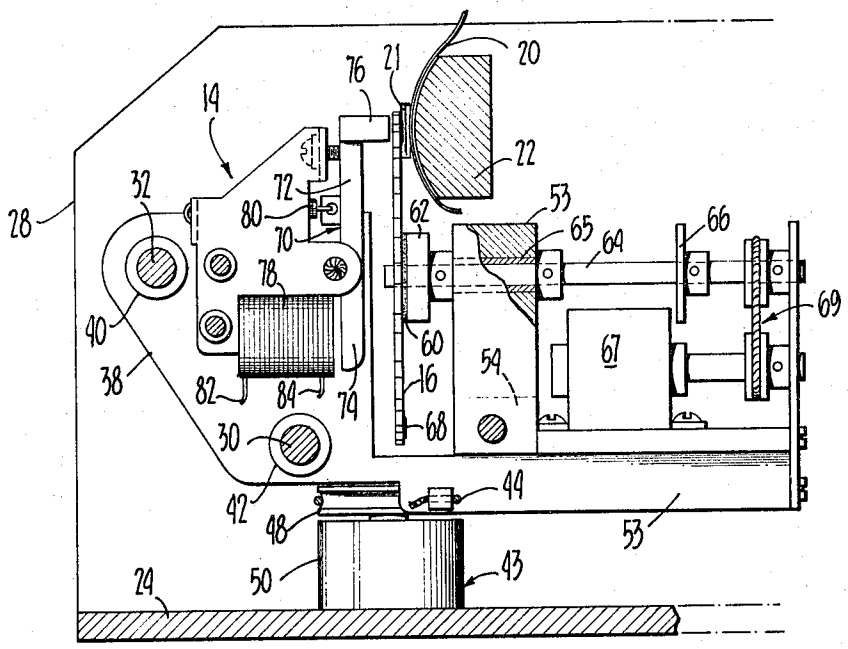

FIG_3

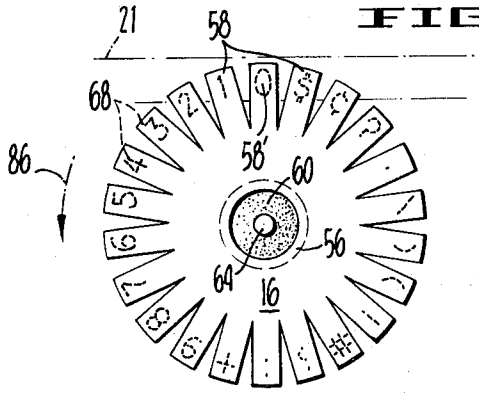

FIG_5

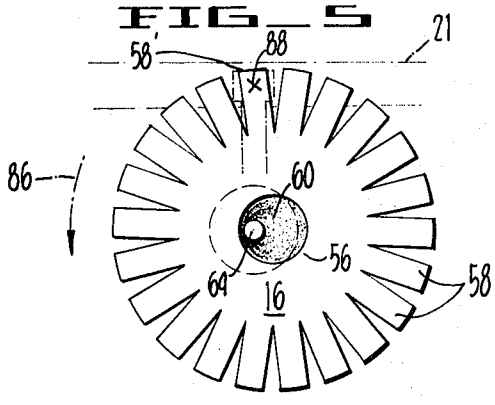

FIG_6

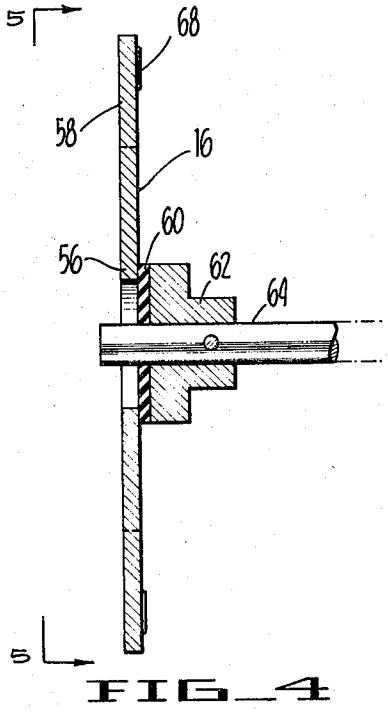

FIG_4

United States Patent Office

3,384,216

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3,384,216

RESILIENTLY MOUNTED FONT WHEEL

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7 Claims. (Cl. 197—18)

ABSTRACT OF THE DISCLOSURE

A printer having a platen, a continuously rotatable font wheel, and a print hammer mechanism wherein the font wheel mounting includes a resilient member for permitting the wheel to move laterally a short distance as a type on the periphery of the wheel is momentarily clamped into printing engagement with a sheet of paper or an inked ribbon by actuation of the print hammer.

Cross reference to other related applications

The apparatus disclosed in this application is related to the apparatus disclosed in application Ser. No. 529,455 filed Feb. 23, 1966, by Leland P. Robinson and assigned to the same assignee as the present application.

Background, field of the invention

This invention relates to printing devices and, in particular, to a printing device having a resiliently mounted font wheel rotated at high speed which is selectively engaged by a hammer mechanism for high-speed printing of characters on paper.

Background, prior art

With the advent of electronic data processors and high speed electrical data signal generation and transmission as found, for example, in high-speed paper tape and magnetic tape handling systems, there has been a demand for devices which can transform electrical signals or codes into permanent meaningful human-readable form at very rapid rates. One known device which fulfills these objectives is a high-speed printer that incorporates a font wheel bearing a plurality of printing type at the distal ends of a plurality of spokes forming the wheel. In one form of such printer the font wheel is rotated intermittently from character to character. However, such intermittent operation consumes an unduly large amount of time in starting and stopping the font wheel. In another form of high-speed printer such as that described and claimed in the mentioned application Ser. No. 529,455, the font wheel is rotated continuously and the operating hammer is actuated at the proper time such that it exactly meets or impacts with the desired type-carrying spoke and forces the type into printing engagement with the paper. This latter form of printer is commonly referred to as an on-the-fly printer. The force imposed on the type-carrying spoke must act very rapidly in order to get the type into printing contact with the paper and then away from the paper quickly enough that the movement of the type with the wheel does not cause an undue amount of smearing as it prints.

Summary of the invention

According to this invention a printer comprises a font wheel or disc rotatably mounted such that when any one of the plurality of types are forced into printing relation

with a sheet of paper or inked ribbon by a high-speed hammer, one point of the outer periphery of the wheel is braked or clamped to the paper, thereby creating a new axis about which the whole wheel will tend to pivot and is permitted to do so for a short distance by a resilient mounting of the wheel. In this manner, the printing type in actual printing contact is relatively halted in its travel about the wheel's normal axis of rotation for the period of time it is in contact with the paper or inked ribbon and thus smearing of the impression made by the type is substantially obviated. In addition, the forces generated aid in starting the wheel mounting structure's movement to the next printing position.

Brief description of the figures

The organization and method of operation of the invention may best be understood from the following description when read in connection with the accompanying drawings in which:

FIG. 1 is a partially cutaway perspective of a printer incorporating the present invention;

FIG. 2 is a partial front elevation of the printer shown in FIG. 1;

FIG. 3 is a partial sectional view along the lines 3—3 of FIG. 2;

FIG. 4 is an enlarged cross-section of the font wheel of the present invention showing a preferred embodiment of the resilient mounting;

FIG. 5 illustrates the normal rotation of the font wheel of the present invention; and

FIG. 6 illustrates the principle of operation of the present invention.

In the figures, similar numerals refer to similar structural elements.

Description of a preferred embodiment

In FIG. 1 there is shown partially cutaway a printer **10**, minus a usual cover, which includes a stable frame **12** upon which a carriage assembly **14**, having a font wheel **16** and print hammer assembly **18**, is mounted for straight line movement across the face of a sheet of paper **20** and inked ribbon **21** held adjacent a platen member **22**.

The frame **12** includes a base member **24** and spaced end plates **26** and **28** mounted in upstanding parallel relation to each other. A pair of spaced, parallel, carriage mounting rods or rails **30** and **32** are mounted horizontally between the end plates **26** and **28** near the forward portion of the printer. Platen member **22** extends parallel with the rails **30** and **32** and is rigidly attached to the end plates **26** and **28** rearwardly of the printer. There is thus formed a very rigid frame for mounting the other elements of the printer, as described hereinafter.

The carriage assembly **14** includes a pair of upstanding side plates **36** and **38**. Each side plate has formed therein a pair of openings into which associated bearings or bushings **40** and **42** are secured, as best shown in FIG. 2. The bearings **40** associated with each of the side plates **36** and **38** are in axial alignment and in sliding surrounding engagement with the upper rail **32**. Likewise, the two bearings **42** associated with each of the side plates **36** and **38** are in axial alignment with each other and in sliding surrounding engagement with lower rail **30**. In this manner the carriage assembly is mounted for easy movement in a straight line path of travel between the end plates **26** and **28** and parallel with the platen member **22**. Other well-known structures may be utilized to mount the car-

riage assembly for movement as described, as will occur to those skilled in the art to which subject matter of this disclosure pertains.

A carriage assembly advancing means **43** for sequentially stepping the carriage assembly **14** from left to right during printing of a line and for rapidly moving the carriage assembly back to its leftmost position is shown as including a relatively flexible, substantially inextensible cable **44** which is trained about an idler pulley **46** and a driving capstan **48**, and connected to opposite side plates **36** and **38**. The capstan **48** is coupled to a source of mechanical power **50**, which may be any well-known spring or electric motor-driven carriage advancing mechanism known in the art to which the present disclosure pertains. One example of such a carriage advancing mechanism is shown in U.S. Patent No. 2,056,364 of Petz. The details of such a carriage advancing mechanism are not shown in the present disclosure in order that the present invention may be more easily illustrated and understood.

The character font wheel **16**, described in more detail below, is rotatably journalled in a mounting block **53** (FIGS. 1 and 3) secured to a pair of arms **54** which extend rearwardly from respective side plates **36** and **38** of the carriage assembly **14**.

The font wheel **16**, as illustrated best in FIGS. 4 and 5, comprises a radially inner central or hub portion **56** and a plurality of radially extending type-carrying spokes **58**. As best shown in FIG. 4, a resilient coupling or mounting member **60** is secured, as by bonding, to one side of the hub portion of the font wheel and concentric therewith. A power shaft connecting block **62** is also secured, as by bonding, to the opposite side of the resilient mounting member and is provided with a central opening into which a power shaft **64** is inserted. The resilient member **60** may be, for example, rubber. The power shaft is journalled in a bearing **65** (shown in FIG. 3) secured to the mounting block **53** and is connected to any suitable source of rotative power, such as a constant speed electric motor **67** and suitable gearing **69**.

The distal or radially outer end of each spoke **58** is formed with, or has secured thereto, a character type **68** facing generally toward the platen; each spoke has a different character type wherein a set or font of character types is formed which may be numeric symbols, or the alphabet plus numeric symbols, and other special symbols, such as punctuation marks, etc., as required.

The spokes **58** are formed or so constructed so as to be flexible in the direction transverse to the plane of the wheel in order that they may be deflected from their normal position and driven into printing contact with the inked ribbon **21** or paper **20**. The spokes are also constructed so as to be relatively rigid or stiff in the direction parallel to the plane of the wheel. In other words, the spokes are resistant to bending in the tangential direction but are resiliently flexible in the axial direction.

It is to be noted that the topmost spoke, designated in FIGS. 5 and 6 as **58'**, is directly adjacent the portion of the inked ribbon **21** and paper **20** that is held in contact with the platen member **22**. This position of any one of the spokes is the operative printing position.

In order to detect which spoke **58**, and accordingly which character type **68** is in operative printing position as the wheel **16** rotates, a character decoding disc **66** (FIGS 1 and 3) is attached to the shaft **64**. The decoding disc may be part of a magnetic or photoelectric decoding subsystem well-known in the art to which the present disclosure pertains, for detecting or indicating that a particular character type is in operative printing position.

The print hammer assembly **18** includes a hammer member **70** pivotally mounted in the carriage assembly **14**, for movement in a plane normal to the plane of the character wheel **16**. As best shown in FIG. 3, the hammer member includes an upper arm **72** and a lower arm **74**. The outer end of the upper arm is provided with a hammerhead **76** which is positioned just rearwardly of the printing position of the type **58'**. A hammer actuating solenoid **78** is mounted in the carriage assembly **14** at a position just rearwardly of the lower arm **74**. The hammer member **70** is biased in the counter-clockwise direction, as viewed in FIG. 3, by a spring **80** so that normally the hammerhead **76** is held out of contact with the wheel **16** and the lower arm **74** is spaced from the solenoid. Upon application of an electrical signal to leads **82** and **84** associated with the solenoid, the hammerhead **76** is caused to rapidly pivot in the clockwise direction and engage the upper or distal end of the upright type-carrying spoke **58'**.

As the hammerhead **76** pivots from its normal unenergized position (as shown in FIG. 3) to its energized or printing position, it engages the backside of the distal end of the upright axially resilient spoke **58'**. The spoke flexes and its associated type **68** is forced into firm printing engagement with the inked ribbon **21** and paper **20**; such action has the effect of clamping the rapidly moving flexed spoke **58'** to the inked ribbon **21** and paper **20**.

The effect of this clamping action is graphically illustrated in FIG. 6 with some exaggeration to more easily show the effect. In this figure the direction arrow **86** indicates the direction of rotation of the front wheel **16** about the axis of shaft **64** due to the rotative power from shaft **64**. As the type **68** associated with spoke **58'** clamps to the inked ribbon **21** and the paper **20**, movement of the upper or outer end of the upright spoke **58'** is braked or arrested and the entire disc pivots to the right about an imaginary axis indicated by cross **88** in FIG. 6. This pivoting is illustrated in FIG. 6 wherein there is shown in dashed lines the normal position of the hub portion **56** of the font wheel **16** and in solid lines the pivoted position of the entire font wheel **16** with respect to the power shaft **64**. This pivoting action is accommodated by the flexible resilient mounting member **60**. Of course, as the font wheel **16** pivots toward the right, it compresses the resilient mounting member **60** and will impose a rightwardly directed force on shaft **64**, which force is transmitted through the shaft mounting block **53** to the entire carriage assembly **14**. There is thus imposed on the carriage assembly **14** a force which can substantially aid the beginning movement of the assembly to the right for positioning it at the next printing location for printing of the next character. The carriage advancing mechanism **50** is suitably in synchronism with actuation of the hammer member **70** and will accordingly furnish the necessary force to fully move the carriage assembly **14** to the next rightward printing position. The force imposed on the carriage **14** by the clamping of the font wheel aids substantially in taking up any slack in cable **44** and gears that may be part of the carriage advancing mechanism **50**, thus substantially aiding the initial movement (acceleration) of the carriage to its next succeeding printing position.

The theory of operation in the pivoting of the font wheel **16**, as described above, at the time of clamping of the upper end of the character spoke **58'** is best described as follows:

With narrow spaces between adjacent spokes **58**, the font wheel **16** may be considered to be a thin flat disc. The moment of inertia I_{64} of the wheel about the axis of shaft **64** can be expressed approximately as,

$$I_{64}=\tfrac{1}{2}mr^2 \qquad (1)$$

where m is the mass of the wheel **16** and r is the radius of the wheel.

The moment of inertia of the wheel about clamping point **88** can be expressed approximately as,

$$I_{88}=I_{64}+ms^2 \qquad (2)$$

where I_{64} is the moment of inertia as set forth in Equation 1 above, m is the mass of the wheel, and s is the distance from clamping point **88** to the center of gravity of the wheel. The distance from clamping point **88** to the center of the wheel (which can be shown to be the center

of gravity of the wheel) is substantially equal to the radius r of the wheel; hence, Equation 2 can be set forth as,

$$I_{88}=I_{64}+mr^2$$
$$=\frac{1}{2}\ mr^2+mr^2$$
$$=\frac{3}{2}\ mr^2 \quad (3)$$

The angular momentum P_{64} of the continuously rotating font wheel **16** about the axis of shaft **64** can be expressed as,

$$P_{64}=I_{64}\omega_{64} \quad (4)$$

where I_{64} is the moment of inertia as set forth above in Equation 1, and ω_{64} is the angular speed of the wheel about shaft **64**.

By the elementary physical principle of conservation of momentum, the momentum of the wheel **16**, after braking by the clamping action of hammerhead **76**, must be equal to the momentum prior to clamping, which is the momentum as defined in Equation 4 above.

After clamping by the hammer **76** the momentum P_{88} about clamping or pivot point **88** can be expressed as,

$$P_{88}=I_{88}\omega_{88} \quad (5)$$

From Equations 4 and 5 there is thus established the following identity,

$$I_{64}\omega_{64}=I_{88}\omega_{88} \quad (6)$$

From Equation 6 it can be seen that the font wheel will pivot about clamping point **88** with a speed ω_{88} which can be expressed as,

$$\omega_{88}=I_{64}\omega_{88}/I_{88} \quad (7)$$

or, by substituting Equation 3 into Equation 7 the following identity holds true,

$$\omega_{88}=\frac{1}{3}\omega_{64} \quad (8)$$

Thus, it can be understood that the font wheel **16** will pivot about clamping point **88** with an angular speed one-third as great as the speed of rotation of the unclamped wheel about shaft **64**.

Pivoting of the font wheel **16** about clamping point **88** will impose a rightwardly directed force F on the resilient mounting member **60** which can be expressed as,

$$F=1mr\omega_{64}/2t \quad (9)$$

where m is the mass of the font wheel **16**, r is the radius of the wheel, ω_{64} is the angular speed of the wheel about shaft **64** prior to the clamping action, and t is the time period of the clamping action.

This force F compresses the resilient member **60**. As mount **60** is compressed, the force F is transferred to the shaft **64** which then tends to move the carriage assembly **14** toward the right, as described previously. Upon unclamping of the spoke **58'** when the hammerhead **76** rebounds from the character type, the font wheel is once again free to be rotated about the axis of shaft **64** and the resilient mount **60** restores the wheel back to its concentric position with the shaft **64**.

It should be understood that resilient mounting of the font wheel **16** may be accommodated in any suitable manner besides that shown in the figures. For example, block **53** may be made of resilient rubber and the bonded member **60** may be eliminated. The wheel **16** will react in the same manner as described if the shaft **64** is also able to flex laterally. In addition it can be understood that the cable **44** could be made of resilient material, like rubber, to also accommodate the force tending to move the wheel **16** to the right at the time of printing engagement of type **68** with the inked ribbon or paper.

There has thus been described a high-speed printer having a font wheel which is mounted in a manner that takes advantage of the angular momentum of the rotating font wheel so as to substantially eliminate smearing of the printed character and to aid in rapid advancing to the next character printing position.

While the principles of the invention have been made clear in the illustrative embodiments, there will be obvious to those skilled in the art many modifications in structure, arrangement, proportions, the elements, materials, and components, used in the practice of the invention, and otherwise, which are adapted for specific environments and operating requirements, without departing from these principles. The appended claims are, therefore, intended to cover and embrace any such modifications within the limits only of the true spirit and scope of the invention.

What is claimed is:

1. In a printing apparatus, the combination comprising:
- a continuously rotatable font wheel having a radially outer portion traveling in a substantially circular path of travel;
- means for applying a braking force to said wheel at a sole point on said circular path of travel; and
- means for normally maintaining said wheel rotatable about an axis, said maintaining means being resiliently yieldable to permit said wheel to pivot about said point in response to the application of a braking force at said point.

2. In an apparatus according to claim **1** wherein said maintaining means includes,
- a shaft mounted for rotation about said axis and having an end, and
- resilient means secured between said wheel and said end of said shaft.

3. In an apparatus according to claim **1** wherein said wheel includes a hub portion, and wherein said maintaining means includes a shaft having an end mounted for rotation about said axis, and a resilient member disposed between and secured to said end of said shaft and said hub portion of said font wheel.

4. An apparatus for printing on a surface of a sheet of paper comprising;
- a rotatably mounted font wheel having at least one printing type disposed thereon for movement normally in a circular path of travel about a first axis as said wheel rotates;
- means for normally continuously rotating said wheel about said first axis with a predetermined angular momentum;
- means for selectively effecting printing contact between the surface of the paper and said type wherein said printing contact exerts a braking force on said wheel at a sole location substantially on said circular path of travel and substantially coincident with said type; said braking force and said angular momentum reacting with each other to impose a force on said wheel tending to pivot said wheel about a second axis, said second axis being substantially parallel to said first axis and substantially normal to said path of travel at said location;
- means for accommodating pivoting movement of said wheel a predetermined amount about said second axis in response to the reaction of said braking force and said angular momentum, said pivoting movement substantially reducing the speed of said location of said wheel with respect to said paper.

5. A printing apparatus according to claim **4** wherein said wheel includes a plurality of printing types, and a plurality of radially extending spokes each of which have an outer end; respective ones of said printing types being associated with and disposed on respective ones of said spoke ends;
- said spokes being flexible in the direction parallel to said first and second axis and being substantially rigid with respect to each other in the circumferential direction about said first axis.

6. An apparatus according to claim **4** wherein said wheel includes a hub portion, and wherein said means for accommodating pivoting of said wheel comprises a resilient member secured to said hub portion, and a driving shaft secured to said resilient member.

7. An apparatus according to claim 6 wherein said resilient member is comprised of rubber.

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