

- [54] **INDEPENDENT NEEDLE KNITTING MACHINES**
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- [73] Assignee: **North American Rockwell Corporation, Pittsburgh, Pa.**
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- [52] U.S. Cl.....**66/8, 66/57**
- [51] Int. Cl.....**D04b 15/32**
- [58] Field of Search.....**6/57, 8, 78, 1, 54, 111; 310/26, 266, 8**

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[57] **ABSTRACT**

The invention is directed to means for reducing the friction load between the butts of the needles and the needle operating cams of independent needle knitting machines and also for reducing the friction load between the needles and the sinkers of such machines and the yarn knitted thereby. Such reduction of frictional loads is achieved by applying high frequency vibrations or oscillations, suitably in the high sonic to the ultrasonic range, to the needle operating cams of the machine by the use of electromechanical transducers positioned in contact with and for transmission of vibrations to the cam boxes or to a ring on which the cam boxes are mounted.

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5 Claims, 7 Drawing Figures

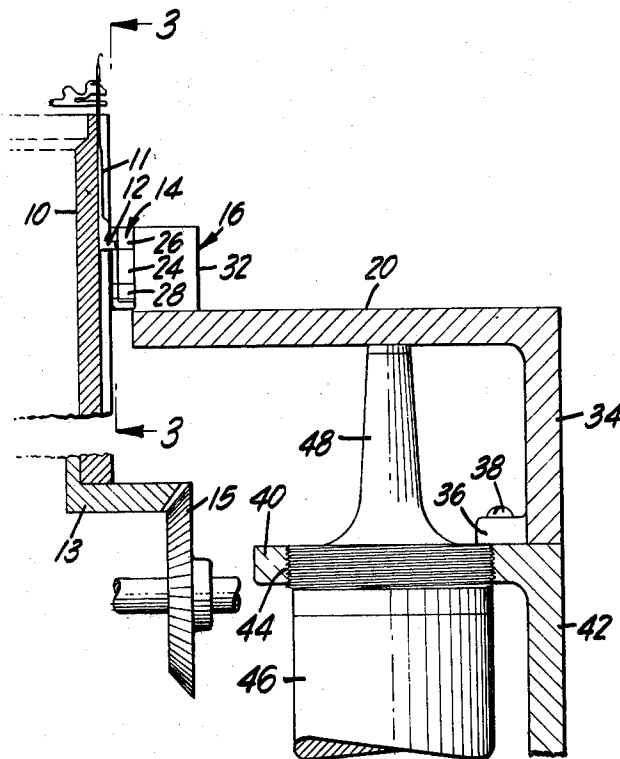


FIG. 1

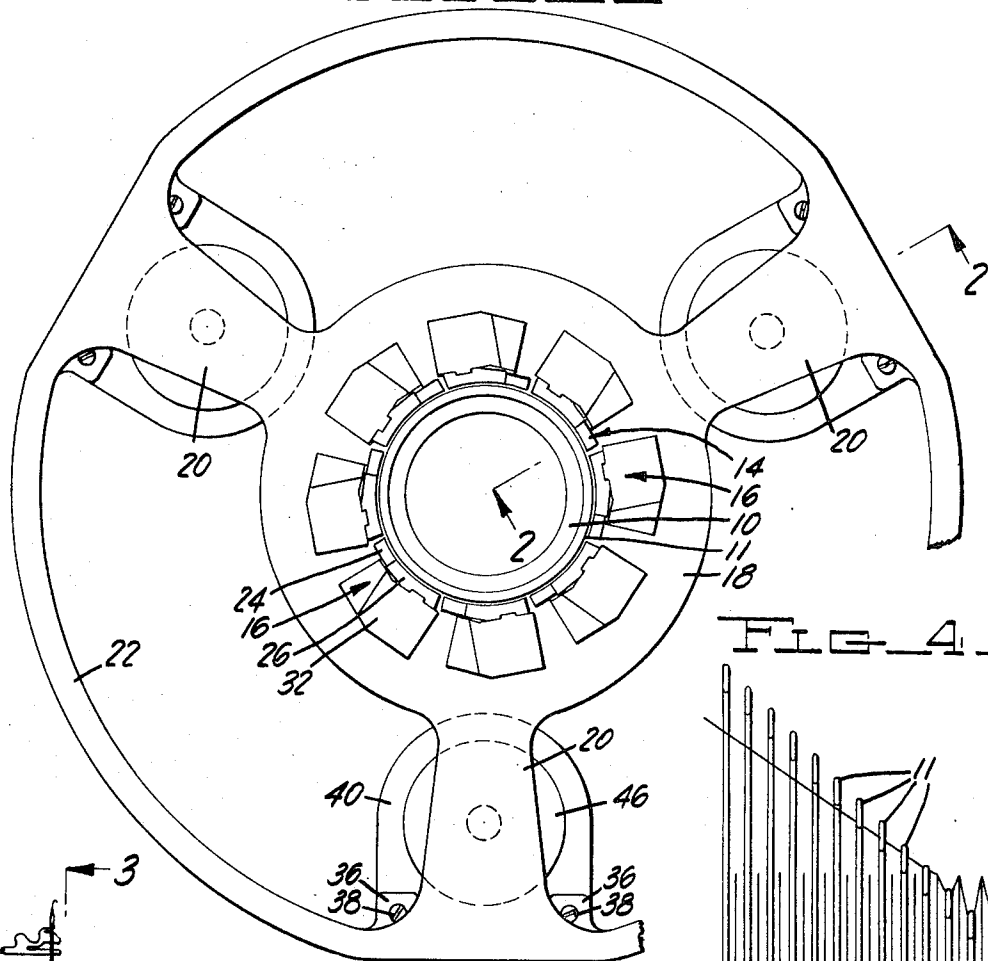


FIG. 4

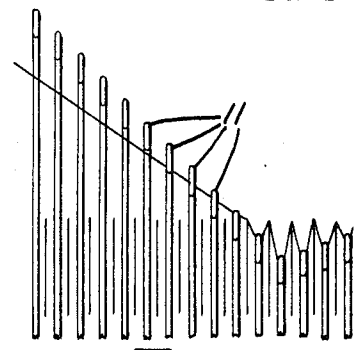


FIG. 2

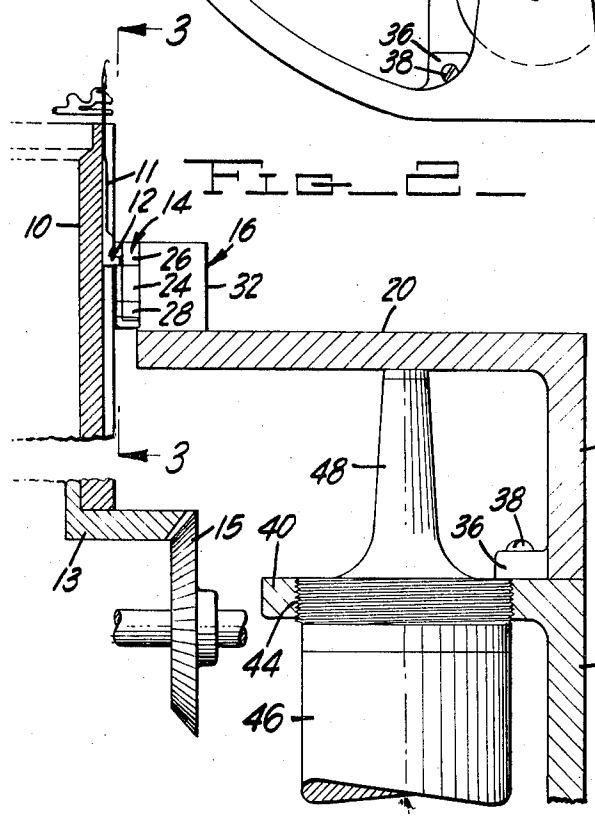


FIG. 3

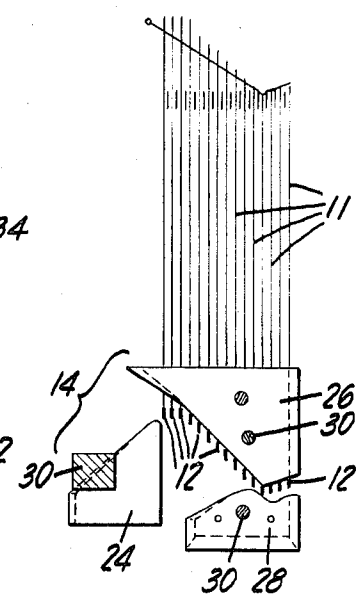
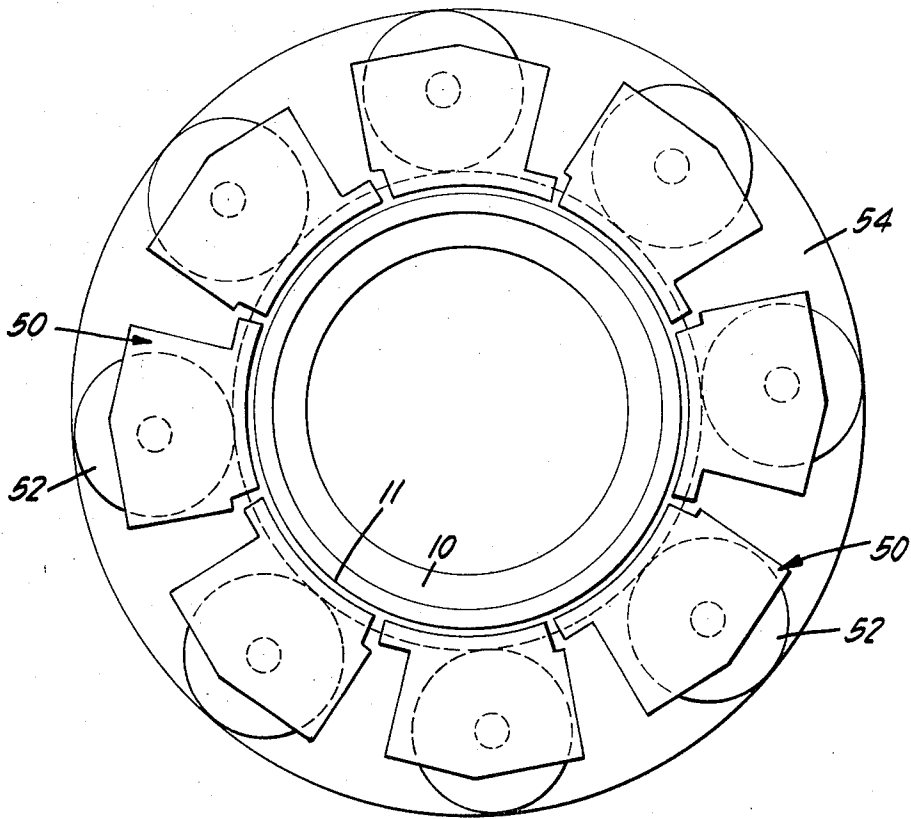


FIG. 5



INDEPENDENT NEEDLE KNITTING MACHINES

BACKGROUND OF THE INVENTION

The instant invention is directed to the solution of friction problems encountered in the operation of independent needle knitting machines, particularly circular knitting machines, as for example machines for producing women's tubular hosiery employing a plurality of knitting stations whereby a corresponding plurality of courses of knitted fabric are produced upon each revolution of the needle cylinder. Hence the following disclosure will be directed to the application of the invention to such machines. It is to be understood however that the use of the invention is not limited to hosiery machines and that it may be equally well applied with attendant advantages to large diameter multifeed circular body fabric machines and to straight independent needle machines.

In order to increase the production of hosiery machines of the type referred to above recent developments have been in the direction of increasing the number of knitting stations and also of increasing the relative speeds of rotation of the needle cylinder with respect to the cam boxes and other elements defining the knitting stations. However difficulties have been encountered in such endeavors inasmuch as the increase in the number of feeds has necessarily required steeper angles for the needle manipulating cams in order to accommodate the additional cam sets around the needle cylinder. For example in an eight-feed women's hosiery machine having a needle cylinder diameter of the order of 4 inches the needle raising and stitch drawing cams at each of the feeds must have angles to the horizontal of approximately 45°. It has been found that the resulting friction load between the needle butts and the cams has limited the speed of rotation of the needle cylinder in commercial use to from 250 to 300 r.p.m., if undue heating, breakage of needle butts and other undesirable effects are to be avoided.

It has been noted however that the use of stitch drawing cams with steeper angles has one salutary effect, namely a reduction in the friction load between the yarn on the one hand and the needle hooks and stitch drawing platforms of the sinkers on the other. This follows from the fact that the steeper the cam angle the fewer the needles and sinkers involved with the yarn in the stitch drawing operation resulting in lower yarn tension at the stitch point. This advantage has not however outweighed the disadvantages heretofore inherent in independent needle knitting machines having steep cam angles.

The principal object of the instant invention is the substantial reduction of the friction load between the needle butts and their operating cams while at the same time preserving and enhancing the reduction of the friction load between the yarn and the yarn manipulating elements, namely the needles and sinkers, presently achieved through the employment of relatively steep operating cams.

BRIEF SUMMARY OF THE INVENTION

In accordance with the instant invention the foregoing object, and other objects as will become apparent, are attained by subjecting the needle operating cams of an independent needle knitting machine, such as a multifeed circular knitting machine, to rapid vibrations or

oscillations of small amplitude the vibrations or oscillations being in the range of 10,000 to 100,000 cycles per second. The rapid vibration or oscillation of the cams, which maintains the needle butts out of contact with the cams, as the needles travel upwardly of the needle upthrow or raising cam and downwardly of the stitch cam, for a substantial portion of each vibratory cycle, greatly reduces the friction load between the needle butts and the cams. As a consequence cams with angles to the horizontal of 45° or greater may be successfully employed with the needle cylinder rotating at much higher speeds than heretofore possible such speeds approximating 600 r.p.m. or higher. The steeper cam angles permitted by the present invention also reduce the number of contacts between the yarn on the one hand and the sinkers and needles on the other and furthermore the vibration of the needles as caused by the vibrating knitting cams result in a decrease in the coefficient of friction between the yarn and such knitting elements thus decreasing the yarn tension at the stitch point.

The vibrations or oscillations of the several cams making up a cam set at each of the knitting stations are obtained through the employment of electromechanical transducers of well known type which transform high frequency electrical impulses into high frequency mechanical impulses the output ends or horns of the transducers being applied directly to each cam set or to rings supporting the several cam sets. The transducers may be of either the piezoelectric or the magnetostrictive types capable of producing vibrations or oscillations at frequencies of the order of 10,000 to 100,000 cycles per second. In the preferred form of the invention the cam set for the several knitting stations are mounted in boxes fixed to a cam supporting member or plate surrounding the needle cylinder the cam supporting plate having a plurality of arms which in turn are supported from the frame of the machine. The transducers are supported in vertical positions to have their output ends or horns resting against the arms of the cam supporting plate.

As is well known transducers of the type referred to produce standing wave patterns having locations of maximum velocity and displacement at intervals of one-half wavelength and locations or nodes of minimum velocity and displacement also at intervals of one-half wavelength the latter being spaced one-quarter wavelength from the former. In the embodiment of the invention the transducers are so located in relationship to the cam sets and the supports for the cam ring that the cam sets are at the location of maximum velocity and displacement and the points of support of the cam ring are at the nodes of the wave pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a multifeed knitting machine incorporating the instant invention;

FIG. 2 is a sectional view on an enlarged scale taken on the line 2—2 of FIG. 1;

FIG. 3 is a sectional view on a further enlarged scale taken on the line 3—3 of FIG. 2;

FIG. 4 is a detailed view on an enlarged scale of the upper portion of FIG. 3;

FIG. 5 is a top plan view similar to FIG. 1 of a circular knitting machine incorporating a second embodiment of the invention;

FIG. 6 is a top plan view similar to FIG. 1 of a circular knitting machine incorporating a third embodiment of the invention; and

FIG. 7 is a top plan view similar to FIG. 1 of a circular knitting machine incorporating a fourth embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and particularly to FIGS. 1 to 3 inclusive there is diagrammatically illustrated a circular knitting machine of the type adapted to produce women's hosiery and the like. The machine includes, in addition to other conventional features many of which are not shown as they are not involved in the instant invention, a rotatable needle cylinder 10 supporting a circle of individually activated needles 11 mounted in slots in the needle cylinder in the usual manner and each having a butt 12 (FIG. 2 and 3). The needle cylinder may be rotated by conventional means indicated by a bevel ring gear 13 on the lower end of the cylinder in mesh with a bevel drive gear 15. The butts of the needles are adapted to be operated upon at each knitting station by the cams of a cam set 14 lying in the path of the needle butts and supported in a cam box 16. The several cam boxes 16, eight of which are shown for an eight-feed machine, are evenly spaced in fixed positions around the needle cylinder and are mounted on a cam ring 18 which in turn is supported by three equally spaced cantilever arms 20 secured at one end to the cam ring and at the other end to an annulus 22. Each cam set (FIG. 3) comprises an upthrow cam 24, a stitch cam 26 and a landing cam 28 the several cams being secured as by pins or bars 30 to a support block 32, the cam set and block constituting the cam box. The cam box may in addition include pattern controlled means for altering cam positions and the like such conventional mechanisms not being illustrated herein as they form no part of the instant invention.

Annulus 22 to which arms 20 are attached includes a downwardly depending skirt portion 34 having a pair of inwardly directed suitably integral lugs 36 below each arm 20 each pair of lugs being secured as by screws or studs 38 to one of a plurality of underlying shelf or flange members 40 carried by an annular frame member 42. Each member 40 is provided with a threaded bore 44 receiving a threaded portion of an electromechanical transducer 46. The displacement amplifier or horn 48 of each transducer extends upwardly with its upper end in contact with the lower side of one of the arms 20. The transducers, which may be of the piezoelectric or magnetostrictive type, are of conventional construction and are available from various manufacturers. Each of the transducers 46 has the capability of transforming high frequency electrical impulses into high frequency mechanical impulses or vibrations of the order of 10,000 to 100,000 cycles per second with the amplitude from the micro-inch to the milli-inch ranges at the output end of the horn thereof. In accordance with the instant invention the several transducers all have the same frequency and amplitude of vibration. Each transducer is so located relatively to

the length of its associated arm 20 and the arms are so dimensioned that the point of contact between the transducer horn and an associated arm 20 lies at a point, at least approximately, one-half of the wavelength induced in the arm by the transducer from the cam set 14 and one-quarter the wavelength from the point of connection of the arm with skirt 34. Hence each cam set lies at or adjacent a point of maximum velocity and displacement imparted to the arms 20 by the transducers. The transducers are operated from a suitable electrical source not shown. The energization and deenergization of the transducers may suitably be under the control of the starting switch of the knitting machine or may be separately controlled if desired. In any event on the start of the knitting operation the transducers are operated and their operation continuing during preferably the entire knitting cycle.

During the operation of the knitting machine the high frequency vibrations imparted to arms 20 cause said arms to vibrate the several cam sets 14. As a result the needles 11 are vibrated or oscillated in planes normal to their butts as they travel the upward slope of the upthrow cam 24 and the downward slope of stitch cam 26 the butts 12 of the needles having only intermittent contact with the cams whereby the friction load between the needle butts and the cams is substantially reduced from the loads heretofore encountered in the operation of otherwise similar knitting machines. Reduction of the friction load permits cams of relatively steep inclines to be employed as for example cams having angles with respect to the horizontal of 45° or more while at the same time permitting increased rotational speeds of the needle cylinder relative to the cam sets. Thus relatively steep angled cams as above mentioned can be employed with the needle cylinder rotating at speeds up to or approaching 600 r.p.m. The steep angled cams also by their nature reduce the friction load between the yarn on the one hand and the needles and sinkers on the other by limiting the number of needles and sinkers which contact the yarn to a minimum as illustrated in FIG. 3. The latter reduction in friction is further enhanced by the vibratory motion of the needles with respect to the yarn during the stitch drawing operation.

DESCRIPTION OF OTHER EMBODIMENTS

Referring now to FIG. 5 a second embodiment of the invention is disclosed. This embodiment, as well as further embodiments hereinafter to be described, includes the needle cylinder 10 and the circle of needles 11 as well as other conventional parts of the knitting machine of the first embodiment. Hence the description of the second and further embodiments will be limited to the novel features residing in the particular mounting of the cam boxes and the means for application of high frequency vibrations thereof.

In this embodiment the several cam boxes 50, eight of the cam boxes being shown, which are equally spaced around the needle cylinder at the knitting stations are individually supported by and secured to the ends of the horns of vertically positioned electromechanical transducers 52. The transducers are of the type previously described for the first embodiment and all have the same frequency and amplitude of vibration. The transducers are mounted on a ring 54 to

which they are affixed. In operation the transducers are driven to impart vibrations of the same frequency and amplitude directly to each of the cam boxes 50.

In the embodiment of FIG. 6 the cam boxes 56, equally spaced around the needle cylinder at the several knitting stations, are supported by a ring 58. Ring 58 is provided with diametrically opposed arms 60 and 62 each arm being supported by and secured to a vertically extending post 64 affixed to the machine frame. The length of the posts between the ring and the machine frame is equal to an odd multiple of the one-fourth wavelength. Transducers 66 of the same general type employed in the previous embodiments are supported to lie in horizontal planes by fixed frame members 68 having threaded openings 70 receiving correspondingly threaded portions of the transducers. The support of the transducers is such that the end of the horn 72 of one of the transducers is positioned to lie in contact with one edge of arm 60 and the end of the horn of the other is positioned to lie in contact with the opposite edge of arm 62. The length of the posts 64 between ring 58 and the points of their support by the machine frame is equal to an odd multiple of one-fourth of the length of the waves induced in the posts by the transducers. In operation torsional vibration is imparted to ring 58 whereby the cam boxes and the cams supported thereby are subjected to horizontal vibrations but with a similar effect on the butts of the needles as obtained by the other embodiments. Inasmuch as the lengths of posts 64 are an odd multiple of a one-quarter wavelength as previously explained the lower ends of the posts are in nodal positions.

The embodiment of FIG. 7 which is particularly applicable to four-feed circular knitting machines includes two pairs of cam boxes 74 one box being provided for each of the four feeds or knitting stations. Each cam box of one pair is carried by and affixed to one of the arms of a right-angled bracket 76. Similarly each cam box of the other pair is supported by one arm of a similar right-angled bracket 78. Each of the arms of the brackets 76 and 78 is secured to and supported by a fixed post 80 secured to and extending upwardly from the machine frame. Electromechanical transducers 82 of a similar type to those employed in the other embodiments of the invention are supported from fixed frame members 84 in positions to have the upper ends of their horns in contact with the brackets 76 and 78 at their respective elbows. The parts are so proportioned that the spacing between the ends of the transducers in contact with brackets 76 and 78 and posts 80 is approximately equal to one-quarter wavelength of the standing wave imparted to the bracket arms by the transducers. Also the spacing between the transducers and the points of securement of the bracket arms to the cam boxes is one-half such wavelength. As a result the cam boxes are located at points of maximum velocity and displacement and the supporting posts at points of minimum velocity and displacement when the transducers are in operation.

In operation the transducers 82 are driven to impart vibrations of the same frequency and amplitude to both

brackets 76 and 78. As a result the cam boxes 74 supported by the arms of the brackets are subjected to vertical vibrations to achieve results equivalent to those obtained by the other embodiments.

Having thus described my invention in rather complete detail, it will be understood that these details need not be strictly adhered to, and that various changes and modifications may be made all falling within the scope of the invention.

I claim:

1. In an independent circular knitting machine having a slotted needle cylinder with a series of butted needles received in the slots and cam means at a plurality of knitting stations for operating on the butts of the needles to cause them to follow needle raising and lowering paths upon relative movement of the needles past the cam means, the improvement comprising:

a plurality of electromechanical transducer means to produce high frequency vibrations,

means mounting said electromechanical transducer means operatively adjacent the cam means at locations spaced at substantially equal distances from each other about the needle cylinder, and

means operatively connecting said electromechanical transducer means to the cam means in a way such that the cam means are subjected to high frequency vibrations in a plane normal to the needle butts during relative movement between the needles and the cam means.

2. A knitting machine as defined in claim 1 wherein said means mounting said electromechanical transducer means adjacent the cam means is secured to said knitting machine and is common to all of said transducer means.

3. A knitting machine as defined in claim 2 wherein said common mounting means comprises an annular plate surrounding said machine which plate has arms projecting outwardly therefrom, each said arm having transducer means associated therewith.

4. In an independent circular knitting machine having a slotted needle cylinder with a series of butted needles received in the slots and cam sets at a plurality of knitting stations around the cylinder for operating on the butts of the needles to cause them to follow needle raising and lowering paths upon relative movement of the needles past the cam sets, the improvement comprising:

a plurality of brackets including a pair of arms projecting from a common point and having free ends to support pairs of the cam sets, the cam sets being mounted adjacent the free ends of said arms, and an electromechanical transducer individual to each said bracket and mounted in operative contact with each said bracket at each said common point.

5. A knitting machine as defined in claim 4 wherein said electromechanical transducers produce standing wave patterns in said arms and the distance from said common point to the free ends of said arms is equal approximately to a one-half wavelength of a standard wave pattern.

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