March 6, 1928. 1,661,262

F. NEWTON

SPINDLE FOR TEXTILE SPINNING APPARATUS AND MEANS FOR DRIVING IT

Filed June 29, 1925 3 Sheets-Sheet 1

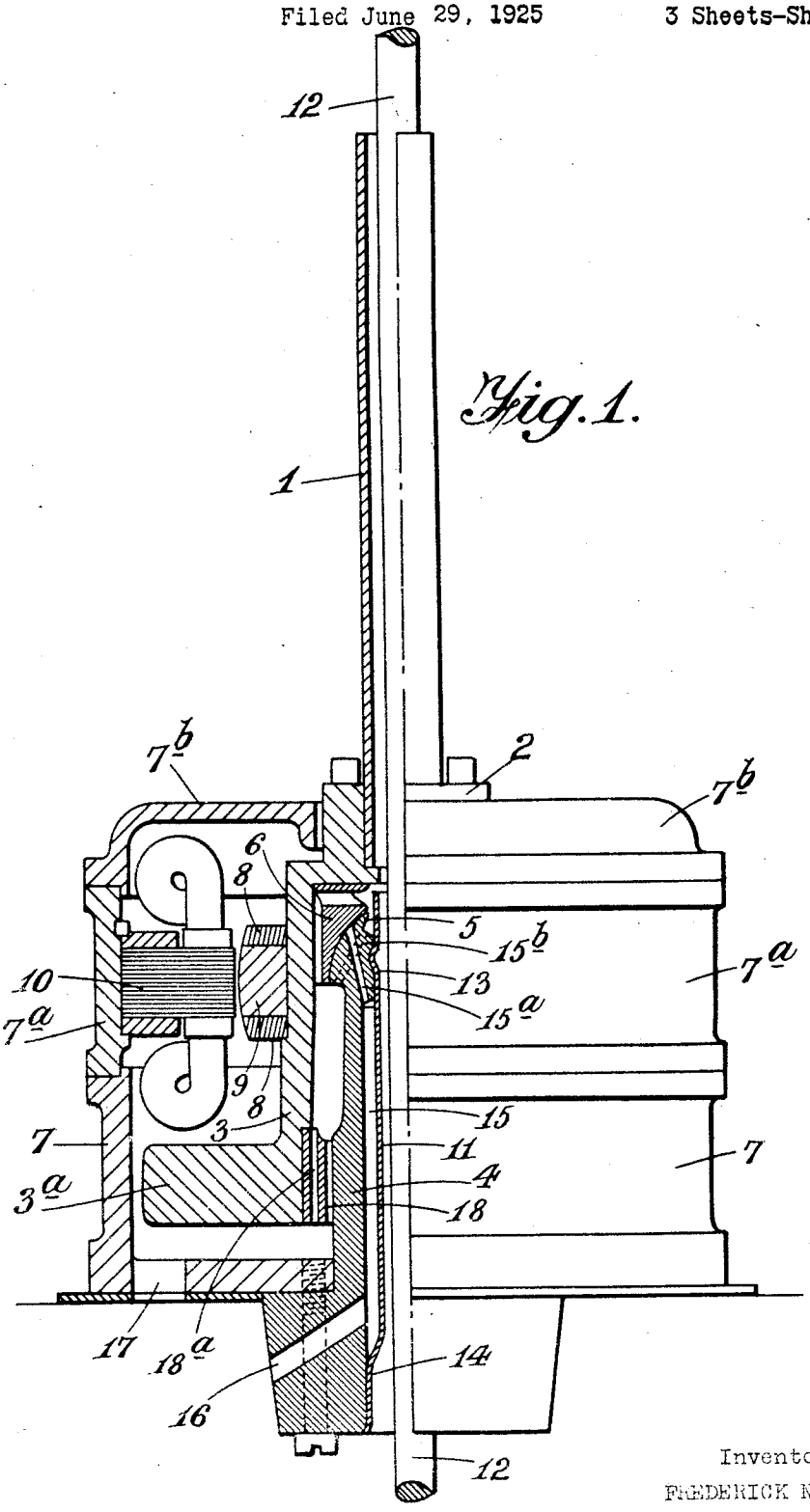

Fig. 1.

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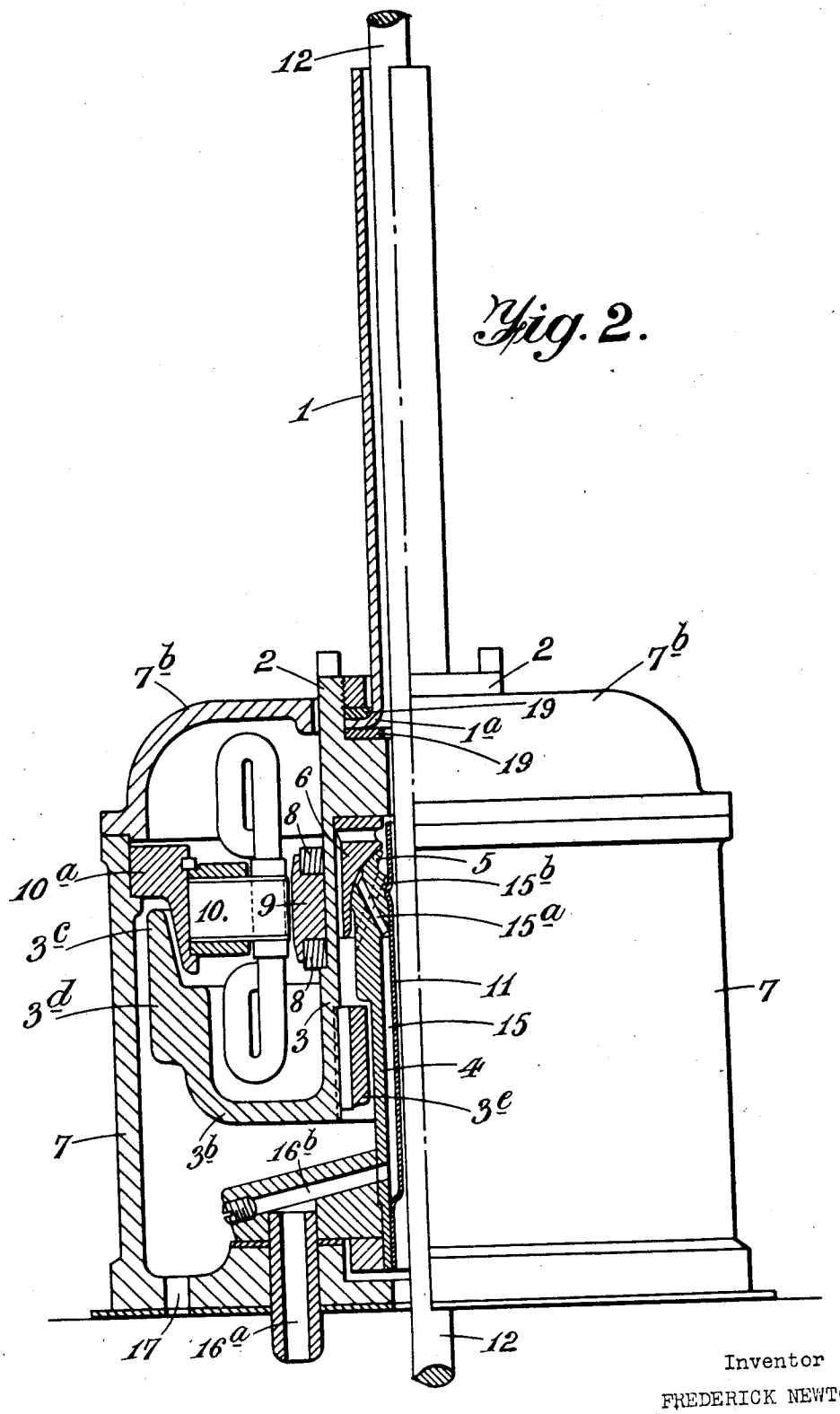

Fig. 2.

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SPINDLE FOR TEXTILE SPINNING APPARATUS AND MEANS FOR DRIVING IT

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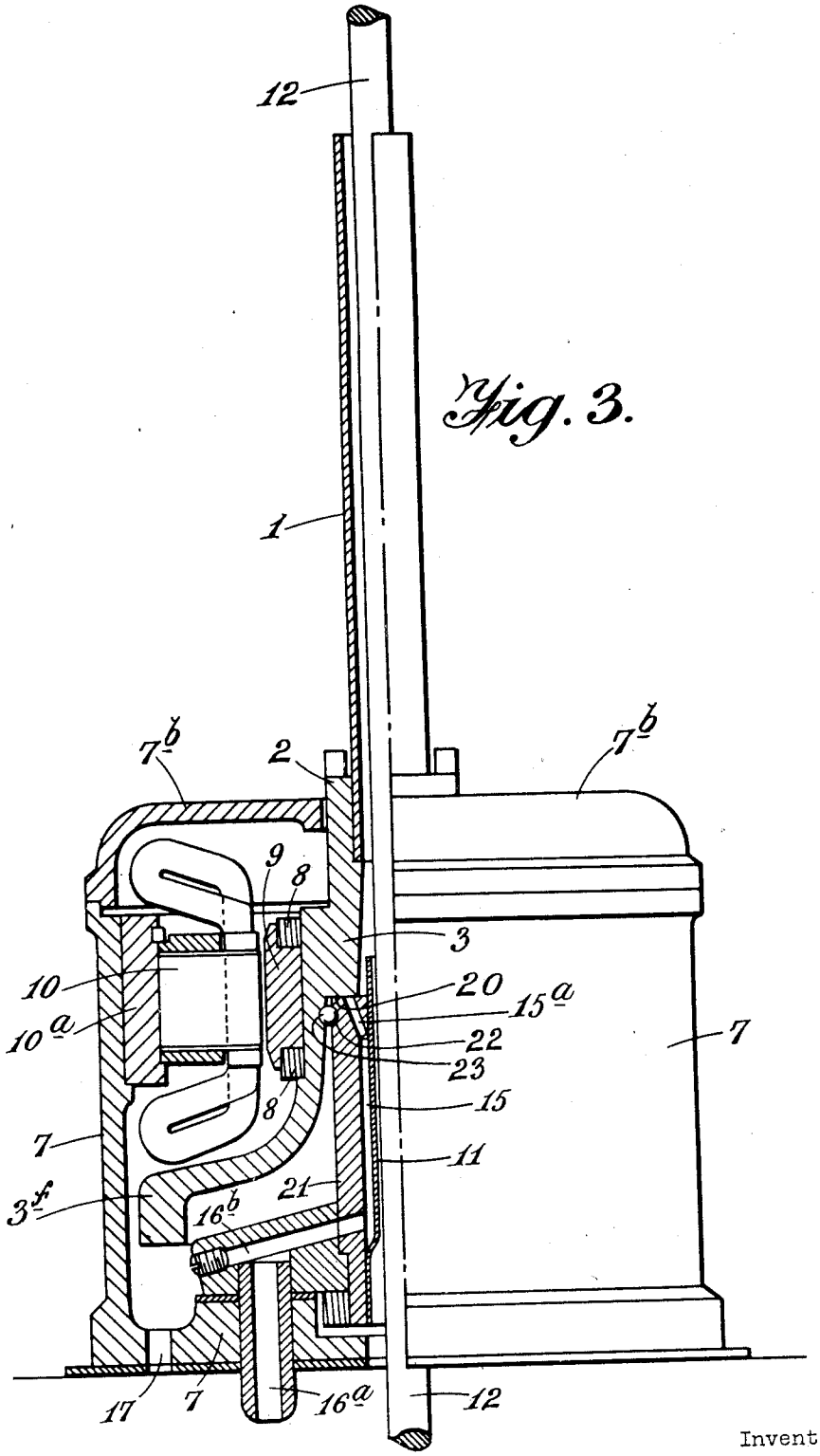

Fig. 3.

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Patented Mar. 6, 1928.

1,661,262

UNITED STATES PATENT OFFICE.

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SPINDLE FOR TEXTILE-SPINNING APPARATUS AND MEANS FOR DRIVING IT.

Application filed June 29, 1925, Serial No. 40,310, and in Great Britain June 30, 1924.

This invention relates to spindles for textile spinning apparatus or machines and it has for object to provide novel forms or constructions of spindle devices whereby in particular high spindle speeds can be successfully obtained in practice. The invention also comprises in combination therewith new or improved constructions or arrangements of driving means therefor.

The invention is applicable to textile spinning machines and apparatus generally, whether for yarns of staple (or discontinuous) fibres or filaments, or for yarns of continuous filaments but particularly to spinning apparatus or machines where very high spindle speeds are desirable or required, as for instance in cap or ring spinning frames, and especially to the spinning apparatus of metiers for the production of artificial yarns of cellulose acetate or other cellulose derivatives by the evaporative method, that is to say wherein the continuous filaments formed by extrusion of solutions of the cellulose derivatives in volatile or vaporizable solvents through jets into an evaporative atmosphere of air or other gaseous medium in which they solidify by evaporation of the solvent, are associated as threads in their travel and continuously twisted and wound by spinning apparatus of the metier, for example cap spinning apparatus.

In various textile spinning machines and apparatus, and especially in the spinning of yarns of artificial filaments continuously with their production by the evaporative method, it is very desirable to twist and wind the yarn at very high spindle speeds. With various spindles of hitherto known constructions it is true that relatively high spindle speeds can be obtained with fair satisfaction, but difficulties are encountered in practice owing to these relatively high speeds and impose a limit to the speeds which can be satisfactorily employed. Attempts which have been made to provide constructions capable of running satisfactorily at much greater speeds have not been attended with practical success.

By means of the present invention constructions of spindle devices can be provided whereby spindle speeds much higher than those hitherto possible with known constructions may be satisfactorily obtained and used. For instance, it is possible with the improved spindle devices to run satisfactorily at spindle speeds of 10000 to 15000 or even 20000 revolutions and more per minute, which is of very great advantage for cases such as before referred to, and especially for the spinning of artificial continuous filament yarns continuously with their production by the evaporative method.

According to the invention the spinning spindle is freely supported, at a point below the collar or other part on which the bobbin, cop tube or the like (all hereinafter designated by the term bobbin) is carried, on a single seating or bearing constituting a suspension support and extends below this point of support as a skirt or equivalent part or member (hereinafter referred to as a skirt), so that the spindle as a whole is freely suspended on the single seating or bearing, which in practice will usually be situated above the centre of mass of the spindle as a whole, the centre of mass of the rotating part of the spindle device being disposed below the centre of suspension. The skirt or equivalent part or member will be so constructed or loaded that the spindle as a whole has the desired degree of balance or stability. The suspended spindle is or may be driven by an electric or other motor or frictional or other driving means, preferably disposed substantially about or substantially opposite the support or suspension of the spindle.

The said suspension support of the spindle may be a spherical seating or bearing, or a plane seating or bearing, or of any other appropriate form, permitting free suspension of the spindle as a whole.

Means are preferably provided for maintaining a supply of oil under pressure to the supporting seating or bearing so as to maintain a film of oil thereon.

The loading or construction of the skirt or equivalent part or member to secure the desired degree of balance or stability in running may be effected or obtained in any appropriate way. For example, the spindle may have a loaded skirt-like lower part of tubular or hollow form; or the spindle may comprise a skirt member the bottom of which is first extended radially outwards and then

upwardly as a relatively heavy upturned flange towards the horizontal plane of the suspension support, or the spindle may have a skirt of downwardly flared form terminating in a rim of increased thickness.

The spindle and its motor or driving means may with advantage be enclosed in a casing below the collar or other part on which the bobbin, cop tube or the like is carried and means may be provided for draining from the casing, oil supplied to the suspension bearing or support as above referred to.

The spindle and the suspension support and the column or member on which the suspension support is formed or provided may be made hollow to give passage to a rod or the like permitting necessary traverse for the cop building or other wind.

In devising and constructing the spindle devices to obtain the results of the invention to the best advantage, it is desirable to dispose the various masses of the rotating parts so as to obtain as far as possible static and dynamic balance or stability, and with this object regard should be had to the following considerations:—

A. As is known, a body containing a given kinetic energy in virtue of the velocity of its mass about its centre of mass, and being free in space, will tend to revolve about such an axis that its speed of revolution is a minimum. In other words, a body revolving at any given speed contains the maximum stored energy when revolving about this axis, which may be called the natural axis of gyration.

B. If a body is considered to be composed of a number of concentric cylinders or rings these have a common axis, which may be called the geometrical axis of the body.

C. If the mass of the body in B is long in the direction of its geometrical axis and small in diameter, the natural axis of gyration will not coincide with its geometrical axis, but these axes will intersect at an angle of 90°.

D. If the mass of the body in B is short in the direction of the geometrical axis and great in diameter, the natural axis of gyration will coincide with the geometrical axis.

E. Assuming the body in D to have its two coincident axes in a vertical position, a point of support may be chosen on these axes somewhere above the centre of mass, about which point the body will have static and dynamic balance or stability,—provided always that the kinetic energy at a given speed, when rotating about this point, on any other axis, is less than that when revolving about the coincident axes.

F. Due to the impossibility of obtaining

(*a*) material having absolute homogeneity,

(*b*) perfect rigidity,

(*c*) absolute precision in construction,

it may not be possible to obtain coincidence of axes as referred to in D although they may be made to lie comparatively close together.

To obtain the results of the invention to the best advantage the spindle device should be constructed and suspended so as to obtain as far as possible coincidence of the natural axis of gyration and geometric axis as referred to in E and thus secure an approximate degree of static and dynamic balance or stability.

For driving the spindle, the exterior of the skirt or equivalent part or member may carry one part, and a surrounding casing the other part of an electric motor, the motor being preferably disposed substantially in a horizontal plane about the suspension support or seating of the spindle, and when this support is a spherical seating, one or both parts of the motor may with advantage have a spherical surface at the air gap concentric with the spherical seating.

The accompanying drawings show by way of example three forms of spindle and drive constructed according to the invention, it being understood that these are given as illustrations only, and that the invention is in no way limited to the particular constructions shown.

Fig. 1 is an elevation half in mid vertical section of one form, while Figs. 2 and 3 are similar views of two other forms respectively.

Referring first to Fig. 1, a hollow spindle 1 is secured at a point below the collar or part 2 on which the bobbin or the like rests, in the nearly closed upper end of a stout walled depending tubular skirt 3 of relatively wide bore, having a thickened part 3^a at the lower part for loading purposes. The tubular skirt of the spindle depends around an upstanding hollow metal column 4, having a convex spherical seating 5 at its upper end integral with or attached to it, upon which rests the concave spherical surface of a ring 6 of phosphor bronze or other suitable material secured in the upper end of the skirt, the spindle with its skirt being thus suspended on the spherical seating 5. The column 4 is erected upon the base of a cylindrical casing 7.7^a which surrounds it and the skirt and is closed at top by a cap 7^b. Around the skirt near its upper end and nearly opposite the spherical seating is built the rotor of an electric motor, conveniently a two-pole polyphase induction motor. As shown, the motor rotor carried by the skirt is a squirrel cage rotor consisting substantially of two washers 8, 8 of copper or other suitable conducting material with a ring of soft iron 9 between them. The stator 10 of the motor is shown as fastened upon a yoke ring 7^a forming part

of the wall of the enclosing casing. The airgap surfaces of the stator or rotor (or it may be of both) are preferably made substantially spherical and concentric with the spherical seating 5. Within the hollow column 4 is a liner tube 11, surrounding an axial traversing rod 12 for a cop building or other traversing motion, the liner tube 11 making joint at top and bottom as at 13, 14 with the column 4 and forming an annular oil channel 15 from which a number of ducts such as 15^a in the top of the column conduct the oil on to the spherical seating 5. The oil is supplied to the annular channel 15 by an inlet passage 16 at bottom under sufficient pressure to float the spindle and maintain a film of oil upon the seating, and it passes down between the skirt and the column 4 and can be drained from the casing by an outlet 17. Auxiliary ducts such as indicated at 15^b can also be provided in the top of the column for draining down oil which may pass over at the top of the spherical seating. 18 indicates a bush fixed inside the bottom of the skirt and formed all round with openings as at 18^a for the escape of the oil into the casing, this annulus also serving in the example shown, as loading to the skirt. In the example the casing 7 is supposed as secured to a fixed bar or other desired part (not shown) of the machine or apparatus.

The spindle with its relatively wide and suitable loaded skirt being freely suspended and rotatable on a single bearing or support can be driven at very high speeds by the motor while maintaining a high degree of static and dynamic balance or stability.

Referring now to Fig. 2, the construction shown resembles that of Fig. 1 in many respects, a spindle skirt being likewise suspended by a phosphor bronze or like ring 6 on a spherical seating 5 formed or provided on the top of a hollow column 4 fixed at bottom in an enclosing casing 7, and the skirt and spindle being driven by an electric motor similar to that shown in Fig. 1 whereof the squirrel cage rotor constituted by washers 8, 8 of copper or other conducting metal and a soft iron ring 9 is carried by the skirt about opposite the spherical seating 5 while the motor stator 10 is carried by a yoke ring 10^a fixed to the wall of the enclosing casing 7 which is closed at top by a cap 7^b. Similarly to Fig. 1, a liner tube 11 embracing a traversing rod 12 is fitted in the hollow column 4 and makes joint therewith at top and bottom so as to form an oil channel 15 communicating by ducts 15^a with the surface of the spherical seating and supplied with oil under pressure so as to float the spindle on the seating and maintain a film of oil thereon, the oil from the seating passing away between the spindle skirt and column into the casing from which it is drained at 17. Auxiliary ducts 15^b are also shown as provided in the top of the column for draining down oil which may pass over at the top of the seating. The oil is shown as supplied to the oil channel 15 by inlet ducts 16^a, 16^b. In the construction shown in Fig. 2 the spindle skirt differs in construction from that shown in Fig. 1, the tubular skirt 3 after depending for a certain distance below the seating 5 being extended radially outwards as at 3^b and then upwards towards the level of the seating as a flange or lip 3^c formed with a thickened portion 3^d. 3^e represents a bush fixed inside the skirt 3 and which serves both to limit angular movement of the combined spindle, other than in the plane of revolution, and also to limit upward movement of the spindle when removing the bobbin, cop or the like.

In the construction illustrated in Fig. 2 the upper part 1 of the spindle on to which the bobbin, cop tube or the like is passed is shown as flexibly attached to the head of the skirt portion, by clamping a bottom flange 1^a with which it is formed between washers 19, 19 of rubber or other elastic material. By thus flexibly attaching the upper part 1 of the spindle to the lower or skirt portion it can take up as nearly as possible its own axis of gyration, giving the least reaction to the complete spindle combination and support as a whole.

Referring now to the construction shown in Fig. 3, the skirted spindle in this form is suspended on a flat seating surface instead of a spherical bearing surface. The flat seating surface 20 is provided on top of a hollow column 21 fixed at bottom in an enclosing casing 7 similarly to the column 4 of Figs. 1 and 2. The upper part of the spindle 1 is fixed in the upper part of the skirt portion 3 which is driven by an electric motor similar to that shown in the other figures, the rotor constituted by copper washers 8, 8 and a soft iron ring 9 being carried by the skirt about opposite the flat seating 20, and the motor stator 10 being carried by a yoke ring 10^a fixed to the wall of the enclosing casing 7 which is closed at top by a cap 7^b. Similarly to the construction Fig. 2, a liner tube 11 embracing a traversing rod 12 is fixed in the hollow column 21 and makes joint therewith at top and bottom to form an oil channel 15. This channel communicates with the flat bearing surface 20 by a number of ducts such as 15^a formed in the top of the column. The oil channel 15 is supplied with oil under pressure so as to float the spindle on the seating 20 and maintain a film of oil thereon, the oil being supplied to the channel 15 by inlet ducts 16^a, 16^b and descending between the skirt and the column 21 from the seating 20 into the casing from which it is drained at 17. The skirt portion 3 of the spindle is formed with

a flat face to rest on the flat seating or support 20, and in order to comply as far as possible with all the principles above explained, relative movement is preferably allowed for between the support and the combined spindile in a horizontal plane. In order not to transmit the centrifugal force of any out-of-balance mass on the rotating part to the support, the diameter of the bearing surface on the skirt portion is made a little greater than the diameter of the bearing surface 20 of the support.

In the construction under description ball races 22 and balls 23 are shown as provided between the upper end of the column and the skirt as an alternative method of limiting angular and vertical movement and also as a limit to the movement of the combined spindle in a horizontal plane as referred to above.

In the construction shown in Fig. 3 the spindle skirt is made of downwardly and outwardly flared form with a thickened rim 3^x at bottom as loading. The spindle skirt could, however, be made of other appropriate forms, for instance such as shown in Fig. 1 or Fig. 2.

It will be seen that with constructions such as hereinbefore described and illustrated the spindle as a whole can be very satisfactory balanced so as to reduced detrimental reaction on the suspension support. It will be understood that any out-of-balance mass on a horizontal plane about the centre of support can react directly on the suspension support, causing vibration, while by employing a relatively large mass on or as part of a skirt or equivalent member or portion below the centre of support, reaction on the point of support can be reduced, this reduction being a function of the sine of the angle between the natural axis of gyration and the geometrical axis (caused by the out-of-balance mass) multiplied by the centrifugal force of the out-of-balance mass.

It is understood that the constructions particularly described and illustrated are given only by way of example and that the invention is capable of many other constructive embodiments, comprising a spindle having a skirt or equivalent part or member freely suspended on a single support and seating.

For instance the rotor of the motor or other driving device need not necessarily be set approximately at the level of the supporting seating; it may be set sufficiently below the centre of the seating partly or wholly to replace other loading of the skirt or equivalent part or member. Instead of employing an electric motor the spindle may be driven by other kinds of motor, for instance an oil turbine, wind turbine or other motor, or it may be driven frictionally, for instance by one or more friction discs or equivalent devices contacting with the skirt or equivalent portion or member of the spindle preferably at about the level of the suspension support, the driving friction surface, or surfaces being preferably a spherical surface or surfaces concentric with the suspension seating when this is a spherical seating. Or the skirt or equivalent part or member of the spindle may even be driven by straps or the like, though this is not to be recommended.

Where a spherical suspension seating is employed, the seating surface on the support may evidently be concave instead of convex and seat a convex surface formed or provided in the skirt or equivalent member or portion.

In the examples illustrated, the spindle and support are stationarily mounted on a fixed part of the machine or apparatus and give passage to a transversing rod whereby the required cop building or other traversing motion is obtained. It is understood, however, that the spindle and support may be arranged to traverse if so desired.

With reference to the term "loading" as applied to the spindle skirt or equivalent member or part, it is of course to be understood that this applies in a general sense and that the loading may be wholly or partly provided or constituted by the formation or mass of the spindle skirt or equivalent part, or member itself.

What I claim and desire to secure by Letters Patent is:—

1. A spindle device for textile spinning machines, characterized in that the spindle is freely supported below the part on which the bobbin is carried, on a single support and extends below this point of support as a skirt, so that the spindle is freely suspended on said single support.

2. A spindle device according to claim 1, characterized in that the centre of mass of the rotating part of the spindle device is disposed below the centre of suspension.

3. A spindle device according to claim 1, characterized in that the disposition of the mass of the rotating part is such that the geometrical axis and the natural axis of gyration are brought into close coincidence, so that the kinetic energy of rotation at any given speed is greater about the desired axis than in any other direction about the point of support.

4. A spindle device according to claim 1, and comprising means for maintaining a flow of lubricant under pressure to the surface of the suspension support of the rotating part of the spindle device.

5. A spindle device according to claim 1, wherein the spindle is suspended upon a spherical support.

6. A spindle device according to claim 1, wherein the spindle is suspended on a plane supporting surface with limited free hori-

zontal movement to provide for lack of coincidence between the natural axis of gyration and the geometric axis of the rotating part.

7. A spindle device according to claim 1, characterized in that angular, horizontal and vertical movement of the spindle is limited by means of balls working in ball races formed on the inner surface of the skirt and on the column carrying the suspension support.

8. A spindle device according to claim 1, comprising means for driving the suspended spindle and operating thereon substantially in the same horizontal plane as the point of suspension.

9. A spindle device according to claim 1, comprising driving means consisting of a motor combined with the suspended spindle.

10. A spindle device according to claim 1, comprising driving means consisting of an electric motor combined with the suspended spindle.

11. A spindle device according to claim 1, comprising an electric motor combined with the suspended spindle and located concentric with and substantially in the same horizontal plane as the point of suspension.

12. A spindle device for textile spinning machines comprising a spindle freely supported on a single suspension support, and a rotor member integral with the spindle and so disposed as to bring the centre of mass of the spindle below said suspension support.

13. A spindle device for textile spinning machines comprising, in combination, a spindle formed with a skirt, a single suspension support for said spindle arranged so that the centre of suspension is above the centre of mass of the spindle, and a motor, the rotor of said motor being rigidly attached to or integral with the spindle.

In testimony whereof I have hereunto subscribed my name.

FREDERICK NEWTON.