Aug. 20, 1935. A. WORMSER 2,011,744

SHEET FEEDING DEVICE

Filed July 16, 1934 5 Sheets-Sheet 1

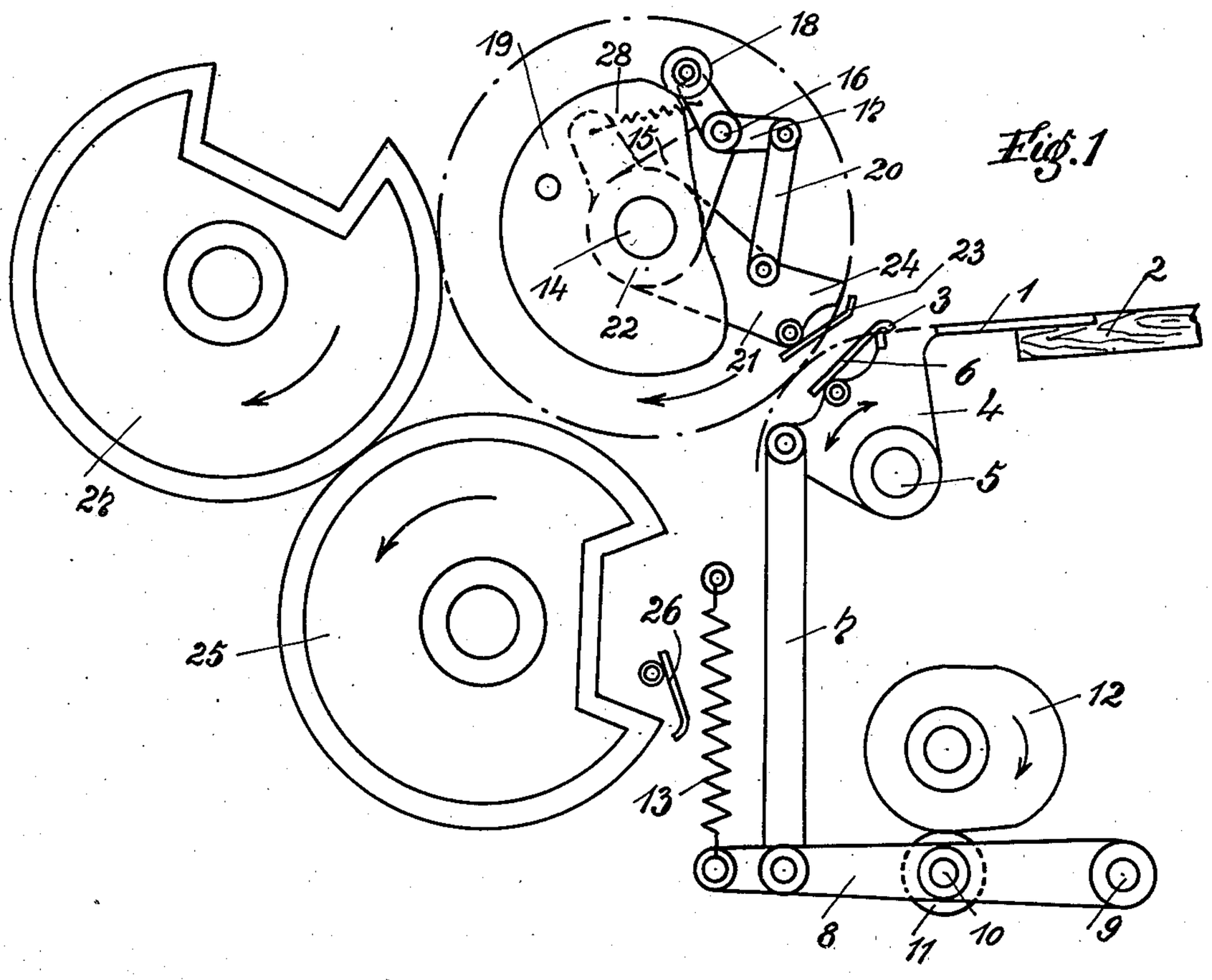

Fig. 1

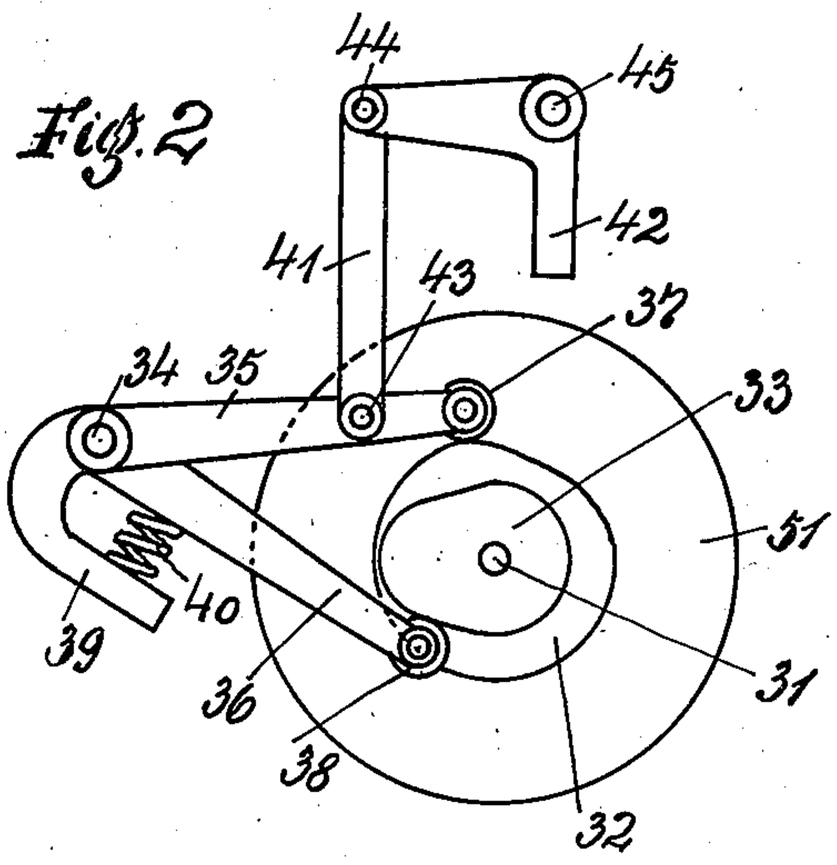

Fig. 2

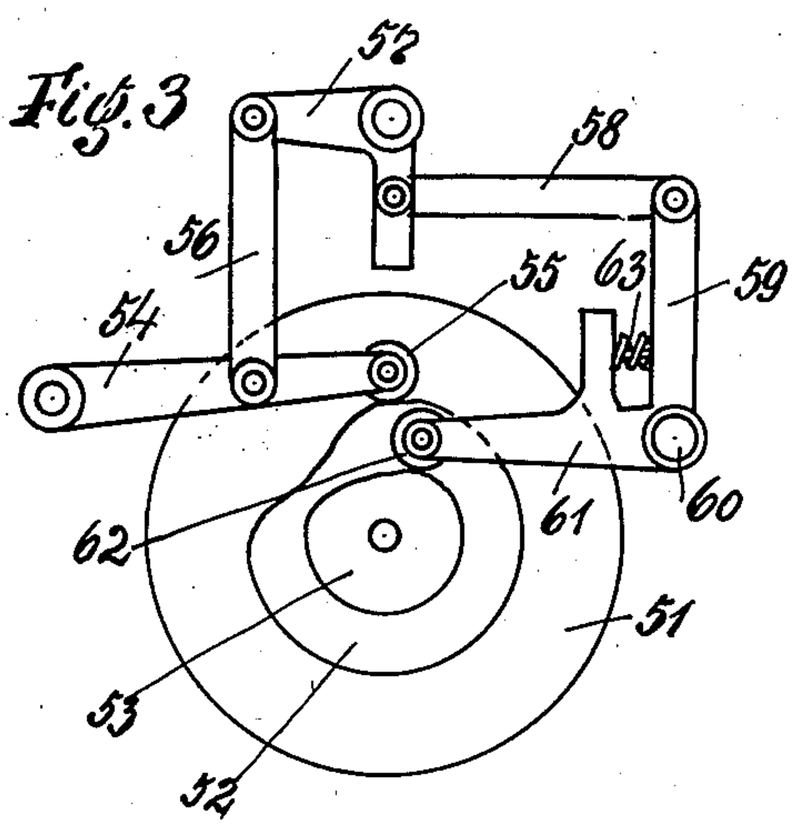

Fig. 3

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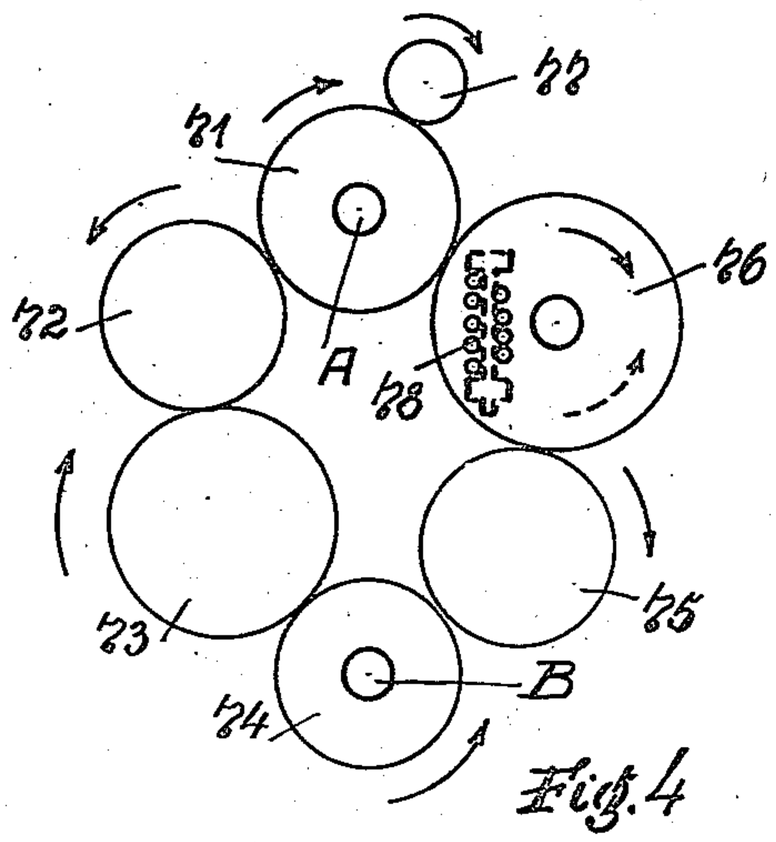

Fig. 4

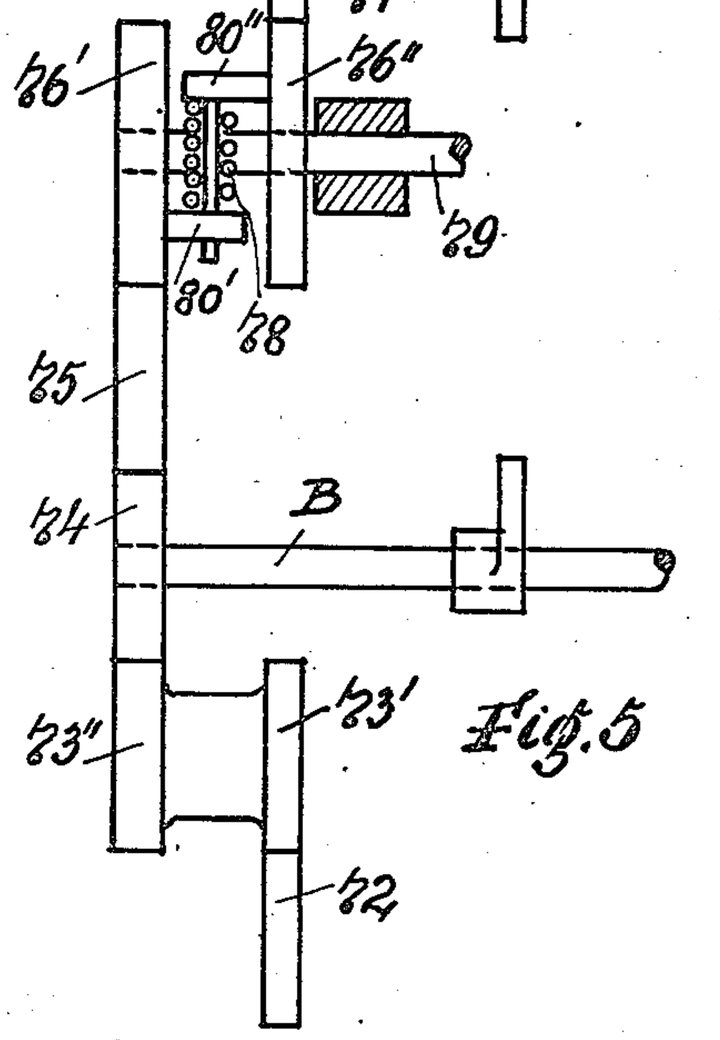

Fig. 5

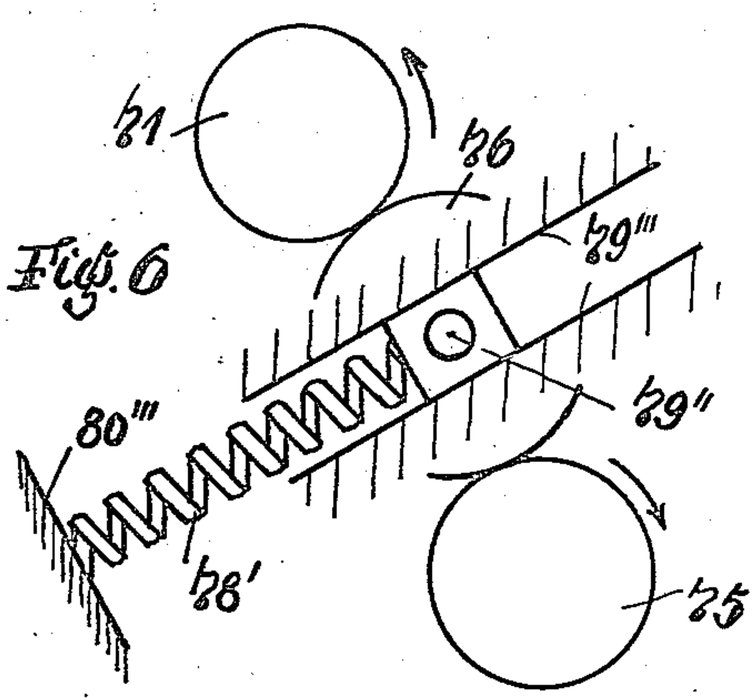

Fig. 6

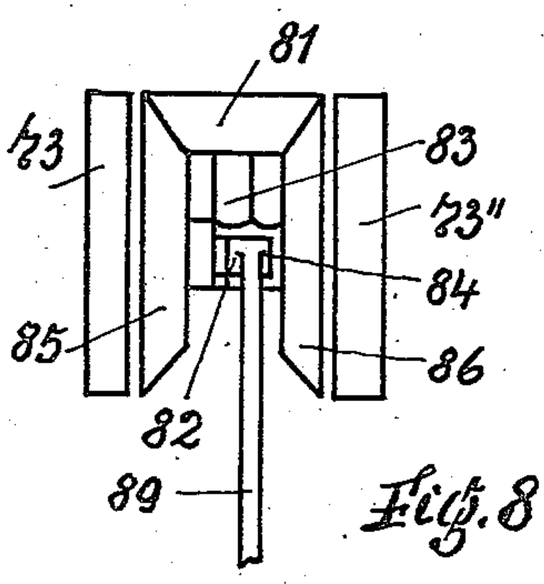

Fig. 8

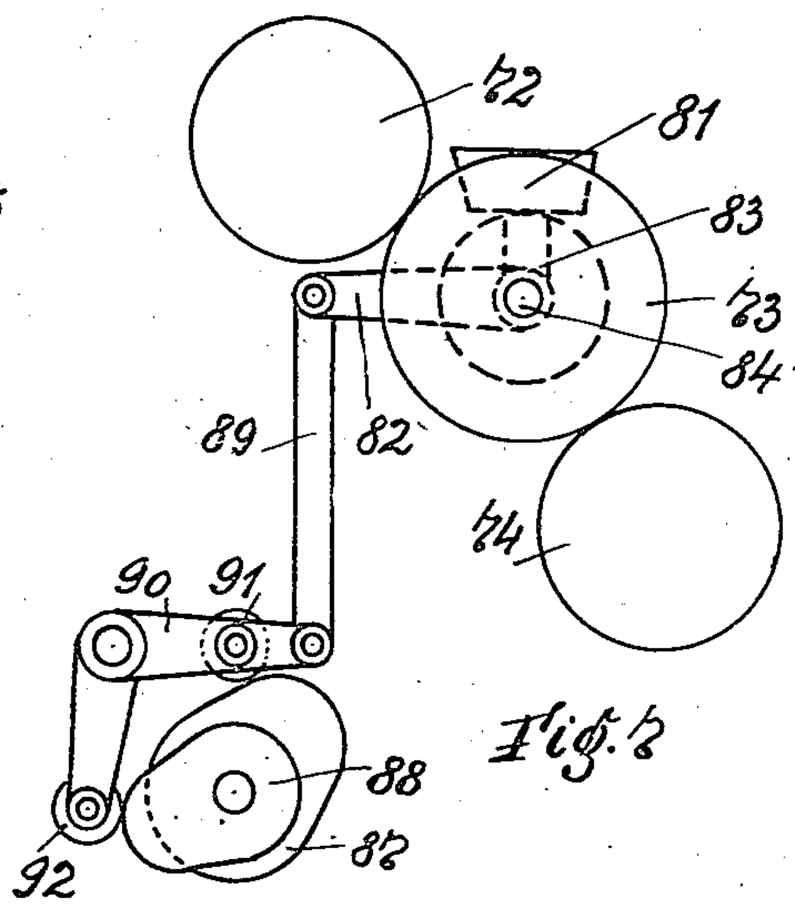

Fig. 7

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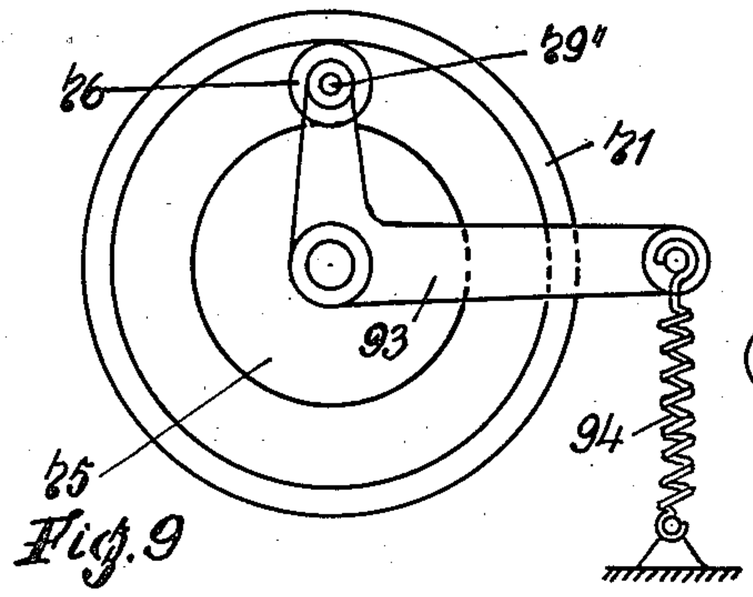

Fig. 9

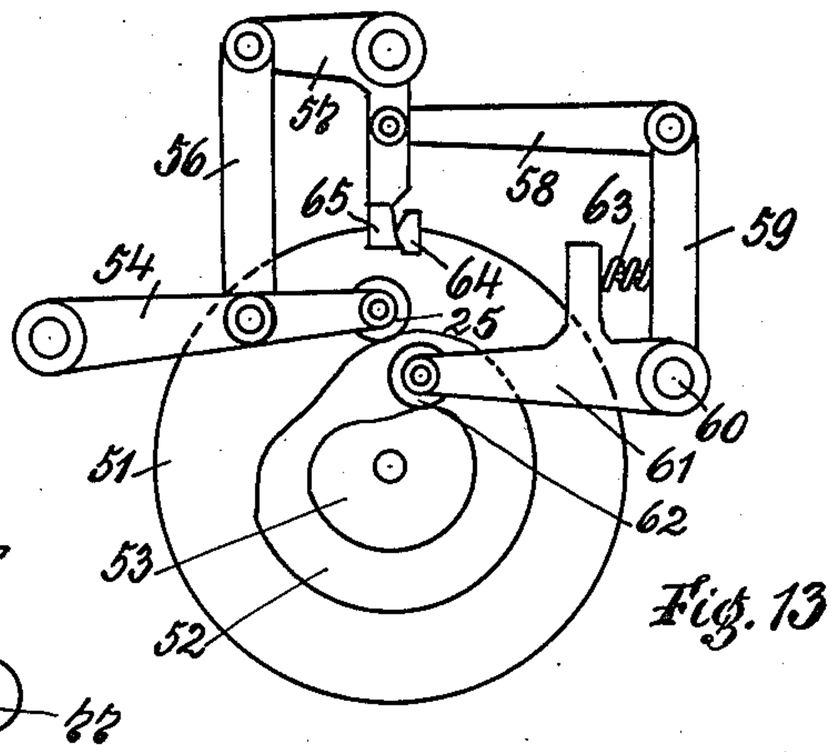

Fig. 13

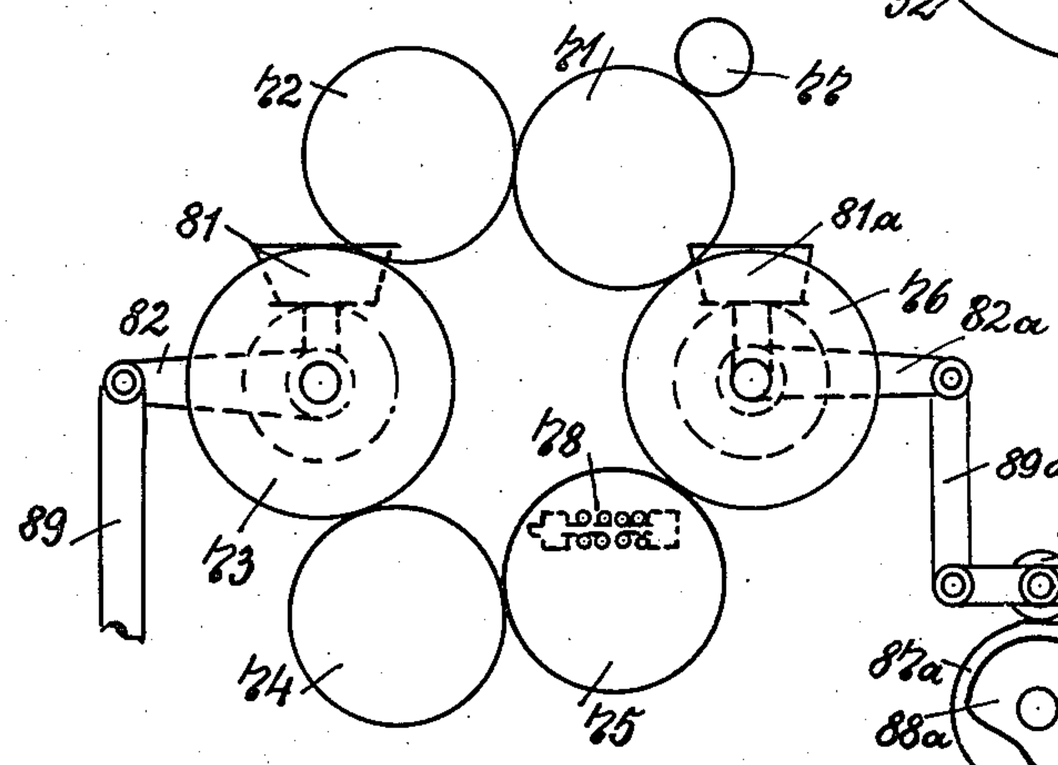

Fig. 10

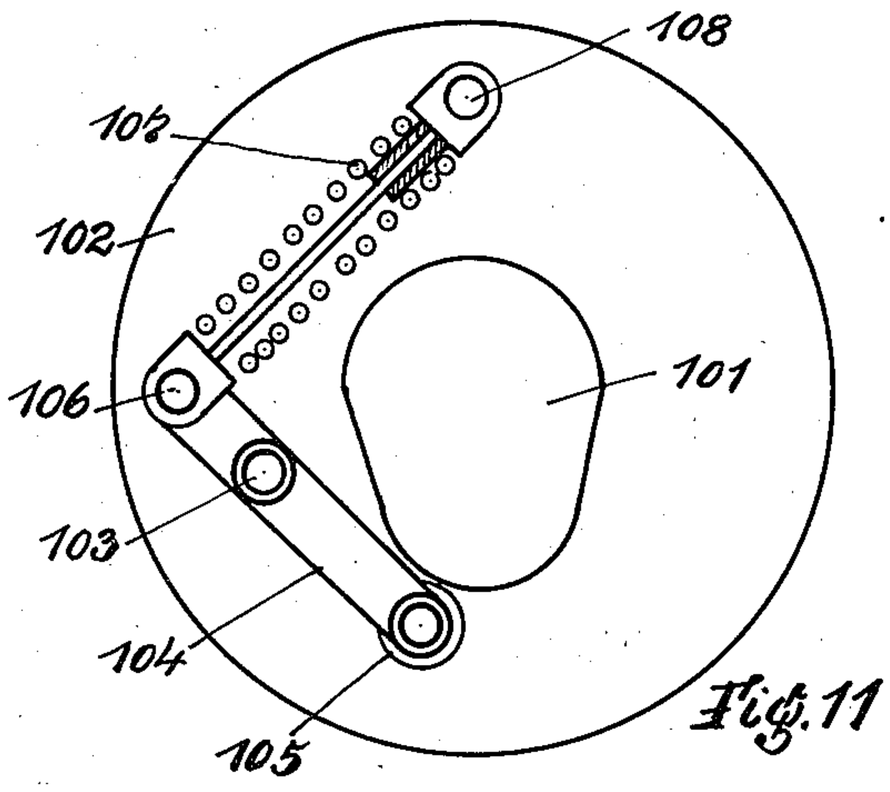

Fig. 11

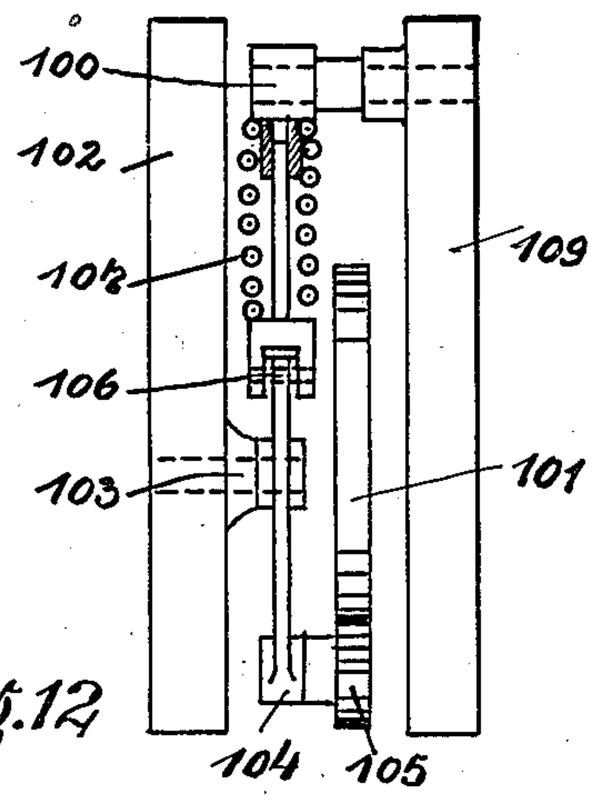

Fig. 12

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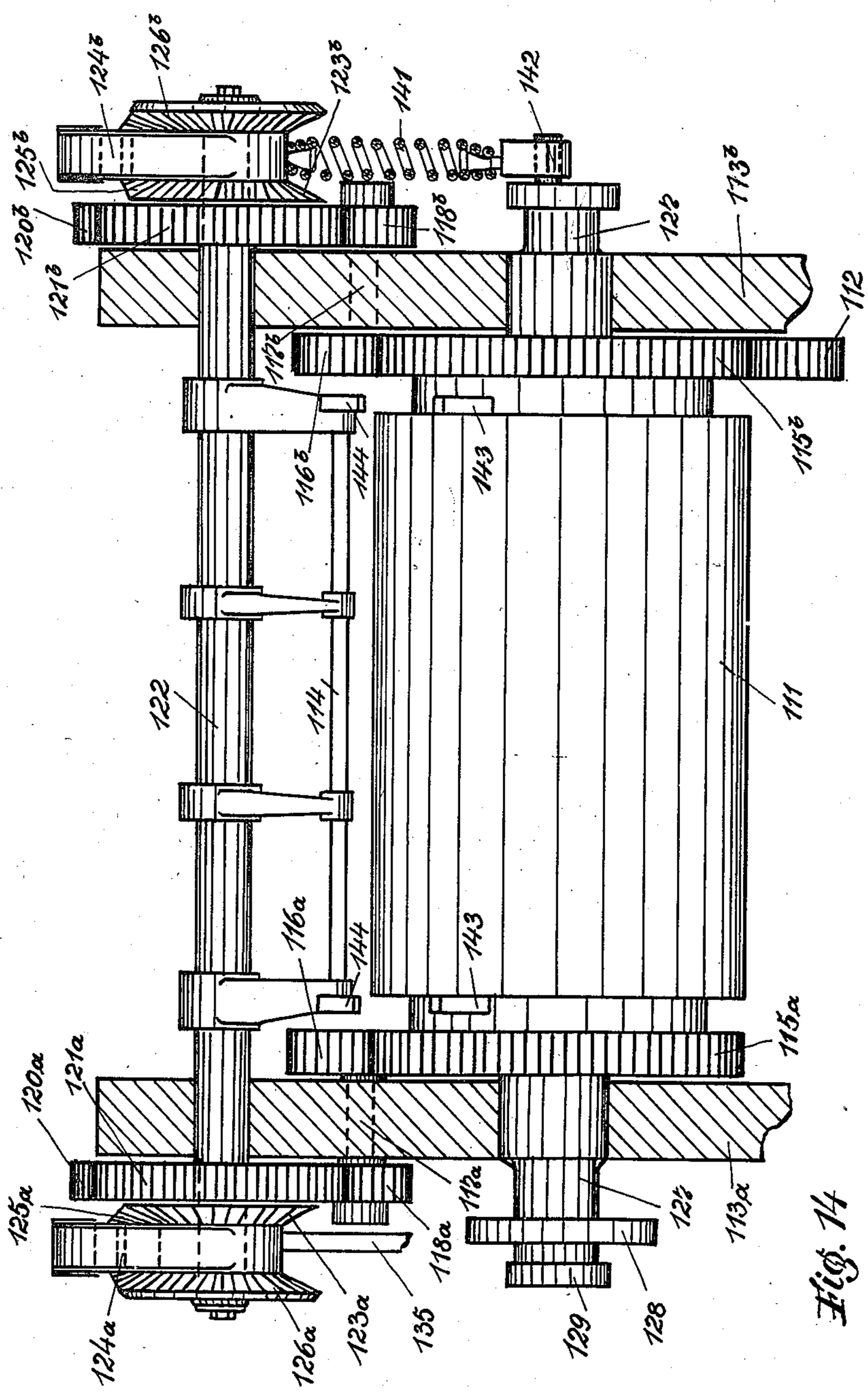

Fig. 14

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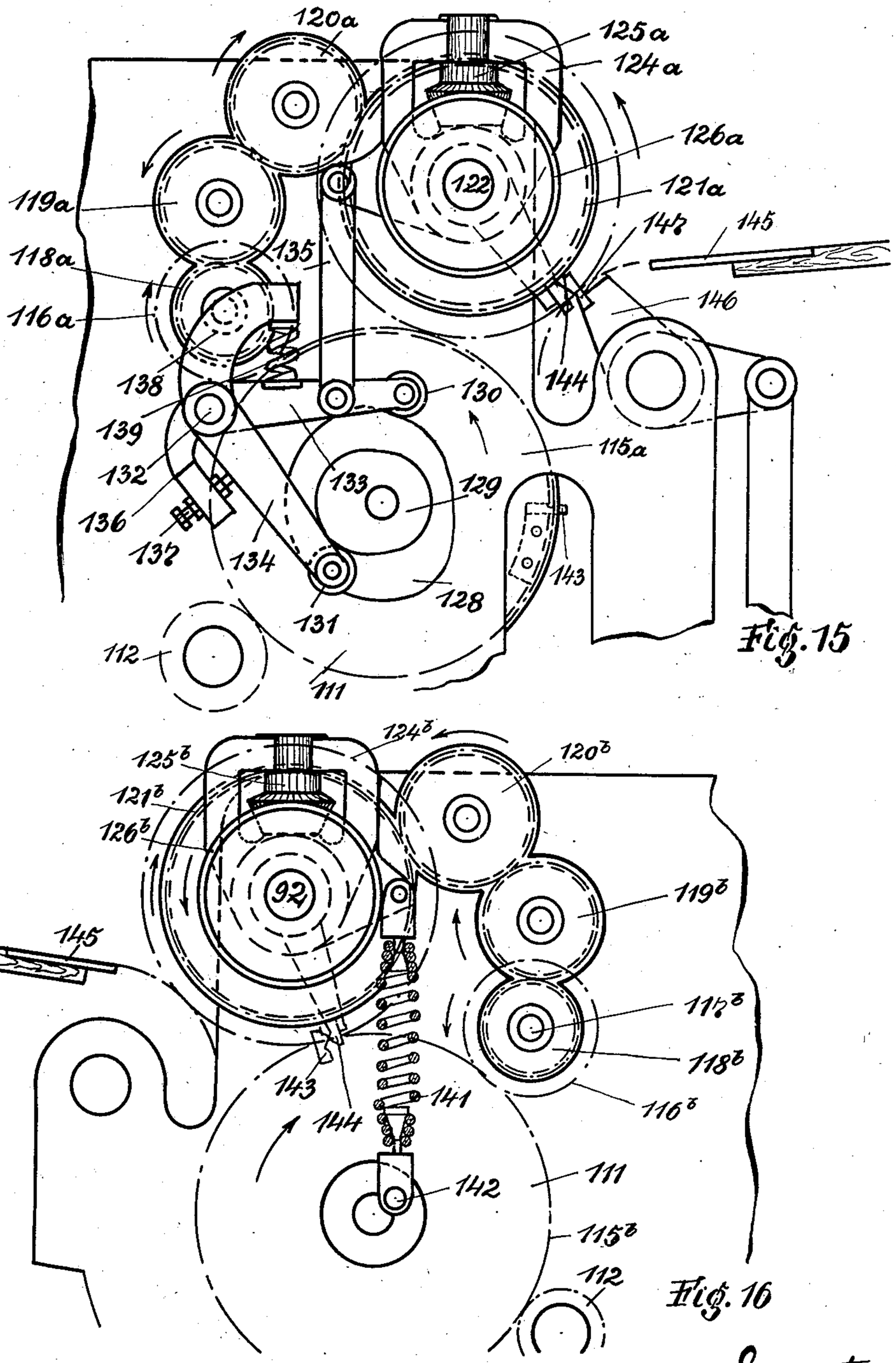

Fig. 15

Fig. 16

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UNITED STATES PATENT OFFICE

2,011,744

SHEET FEEDING DEVICE

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Application July 16, 1934, Serial No. 735,489
In Germany July 8, 1931

13 Claims. (Cl. 271—53)

In sheet printing machines it has formerly been customary to feed the sheet from the registering device to the rotary impression cylinder by simply closing the cylinder grippers as they pass by the front edge of the registered sheet, so that the sheet is abruptly accelerated to the full speed of the cylinder. When the speeds of the machine were augmented, it was preferred to provide oscillating intermediate grippers which seize the sheet at rest and feed it to the cylinder by accelerating it little by little. Nevertheless the acceleration of the intermediate grippers has to be performed in a very short time when the machine is running fast, and consequently strong acceleration forces arise which are detrimental to the smooth running of the machine and to keeping register.

The present invention has for its primary object the provision of intermediate grippers rotating without interruption, but at varying speed which seize the sheet at a speed lower than the cylinder speed and accelerate it up to the cylinder speed. The sheet may be fed to these intermediate grippers from rest or at a low feeding speed by any suitable means.

Another object of the present invention is the provision of new means for moving said intermediate grippers with such exactness as is necessary to keep register. These new means consist in the connection of the intermediate gripper shaft with its driving shaft by two chains of cinematic links in one of which is inserted a spring which gives a continuous pressure to all links of the cinematic chains.

In this sentence and wherever in the following the expression is used, by "cinematic chain" may be designated a series of machine parts pivotally connected, meshing with each other or being in any other movable connection. Each of these machine parts is called "a link of the cinematic chain". If the cinematic chain is of such a kind that the last link is in movable connection with the first link the chain is called a "cinematic circle".

In order that the invention and certain details of the construction may be more readily understood, different embodiments of the invention have been illustrated in the accompanying drawings. It is clear, however, that the invention may be embodied in other and various constructions and forms without departure from the essence thereof, so that the drawings and description are to be taken in an illustrating rather than in a restricting sense.

Fig. 1 is a diagrammatic view of the general disposition of the new feeding mechanism. Figs. 2–13 show diagrammatically different embodiments of the insertion of a spring into a double cinematic chain. Figs. 14–16 show the application of the new cinematic chain for driving the sheet feeding mechanism illustrated in Fig. 1.

Referring to Fig. 1 the sheet 1 which is to be fed and which rests on a feeding table 2 has been brought by hand or by an automatic feeder into contact with the front lays 3 and is registered there at the front and laterally. The front lays 3 are fixed to arms 4 which in their turn are fixed to a shaft 5 and carry the grippers 6 opened and closed by the customary devices. One of the arms 4 is connected by a connecting rod 7 with a lever 8, rocking around the pivot 9. On a pivot 10 fixed to lever 8 turns a cam roller 11 which presses against a rotating cam 12 in consequence of a spring 13 applied to the end of lever 8. By these means a rocking movement is given to the arms 4 and the parts contained by it with speeds depending on the shape of the cam 12.

14 is a shaft rotating at constant speed, the gear wheel which drives it not being shown. On the shaft 14 is fixed an arm 15 at the end of which is fixed a pivot 16. A bell crank lever 17 is adapted to rock about the pivot 16, when the roller 18 rolls on the stationary cam 19 in consequence of the rotation of the arm 15. A spring 28 presses the roller 18 against the cam 19. By means of the connecting rod 20 the rocking movement of the bell crank lever 17 is transferred to arms 21 which are fixed to a sleeve 22 rocking loosely around the shaft 14. The arms 21 carry the gripper device 23, the customary device for opening and closing the grippers not being shown. The effect of the mechanism described in the foregoing is that the grippers 23 participate in the general rotation of the shaft 14, but move slower and faster than this shaft in accordance with the shape of cam 19.

The gripper blocks 24 of the grippers 23 move on a circle around the axis of shaft 14 tangential to the arc described by the blocks of the grippers 6 and to the circle described by the surface of the impression cylinder 25 containing the gripper device 26. A second cylinder 27 presses against the impression cylinder 25 and the sheet to be printed moves between the cylinders 25 and 27.

The operation of the above-described device is the following. During the registration of sheet 1 the arms 4 are at rest in the position shown in the drawings in consequence of the circular part of cam 12. After the sheet has been registered the grippers 6 are closed and the arms 4 are

turned to the left (Fig. 1) with accelerating speed. When the grippers 6 have reached the point where their path touches the path of the grippers 23, the speed of both sets of grippers is equal, but this common speed is lower than the peripheral speed of the impression cylinder 25. Now the front edge of the sheet is transferred from grippers 6 to grippers 23 by the above-mentioned gripper opening and closing devices, not shown. The shape of the cam 19 is such that after the transferring of the sheet to the grippers 23, the speed of the sheet is accelerated up to the point where the front edge of the sheet is transferred from the grippers 23 to the grippers 26 on the impression cylinder 25. In the remaining part of the rotation of the grippers 23 their speed has no influence on the feeding of the sheet, but depends on the relation between the circumference described by grippers 23 and the circumference of the impression cylinder 25. This relation not necessarily is one to one as shown in the drawings.

It is obvious that by the device described the total acceleration from rest to cylinder speed is divided and consequently each of the gripper sets 6 and 23 together with the machine parts bearing them move very smoothly and without excessive accelerating forces arising. It is not necessary that the intermediate grippers move on a circle, but they may be moved on an oblong path by a chain or the like.

Instead of the gripper sets 6 and 23 the sheet can be held by suction nozzles or other holding means.

The front lays can be arranged in combination with the feeding table instead of with the rocking arms 4, in which case they are raised and lowered in the customary way.

It will also be understood that with the introduction of suitable mechanism, the registering of the sheets could be readily accomplished while in motion, that is to say, during the period of their transfer from the feeding table 2 to the impression cylinder 25 for example. Various forms of mechanism well known in the art could be adapted for this purpose. With such an arrangement it would not be necessary to bring the sheets to rest on the feeding table 2, and the transfer means 4 could engage the sheets at the speed at which they are being fed over said table. The arrangement and manner of operation of the other cooperating mechanism could remain substantially as described herein.

In consequence of the play at the pivots the movements of the grippers 6 and 23 are not so exact as it is necessary to keep register at the transferring points. This play at the arms 4 may be overcome by applying the spring 13 immediately at the arms 4. But this has the drawback that the spring must be very strong and at the same time very elastic. At the arms 21 the application of a spring in the customary way is impossible, because these arms rotate. To overcome these difficulties the same fundamental solution can be applied, this solution allowing a large number of different embodiments. The application of this new principle to the above-described feeding mechanism is described subsequently. In the first place however a detailed description of several embodiments showing some of the different kinds of mechanism possible will be given.

In Fig. 2 a rotating shaft is designated by 31. Fixed on this shaft are two cams 32, 33. A lever 35 and an arm 36 rock around a pivot 34. The arm 36 bears a roller 38 and the lever 35 a roller 37, which run on the cams 32 and 33 respectively. The crooked arm 39 of the lever 35 bears against a spring 40 which presses against the arm 36. A connecting rod 41 connects the pivot 43 on the lever 35 with the pivot 44 on the bell crank lever 42, rocking with a shaft 45. This rocking lever indicates that part of the machine which is to be moved by the cams 32 and 33 and which for instance may consist of the intermediate grippers of a printing press. It has been mentioned before that the part to be driven with absolute exactness is to be connected with a driving shaft by two cinematic chains and that a spring is to be inserted in one of them. In this case the cinematic chains are very short and simple. The one chain consists of driving shaft 31, cam 32, roller 37 and lever 35. The other chain consists of driving shaft 31, cam 33, roller 38, arm 36, spring 40 and lever 35 again.

This simple device shows all fundamental qualities of the present solution of the problem. On one hand the driven part 35 is subjected to the constant pressure of spring 40 so that any play existing in pivot 34 or resulting from a lack of contact between roller 37 and cam 32 is eliminated (which in this case could be performed by a simple spring with one fixed point applied to the lever 35). On the other hand by employing a cam 33 of suitable shape the elastic deformation of the spring 40 can be made as small as desired so that it even may be under a constant pressure without any deformation at all (which can only be attained by the present solution).

By the double connection of the machine part 35 with the driving shaft 31, as in other cases too, a circle of cinematic links is formed. Such a cinematic circle does away with the play in all links which are a part of the circle, but it does not do so with the parts which are linked to it outside of the circle. Thus the play in the pivots 43, 44, which connect the lever 35 with the intermediate grippers 42 and the play in the pivot 45 are not influenced by the device shown in Fig. 2. If this play is to be eliminated, so that the position of the intermediate grippers 42 in relation to an impression cylinder, which is diagrammatically indicated by the circle 51 concentric to the shaft 31, will be absolutely definite at every moment, it is necessary to form a circle containing both parts of the machine which are to be precisely mutually dependent i. e. the intermediate grippers 42 and the shaft 31. This has been done in a device shown in Fig. 3.

The circle 51 again designates the impression cylinder of a printing press, secured to the shaft of which are cams 52, 53. On cam 52 runs a roller 55 carried on lever 54. This lever is connected by connecting rod 56 with bell crank lever 57 which again designates the intermediate grippers. Another connecting rod 58 connects the intermediate grippers with an arm 59 which turns freely around the pivot 60. About the same pivot rocks an arm 61 at the end of which is supported an idle roller 62. On the upper side of the lever 61 is a lug against which bears a spring 63 the other end of which presses against the arm 59. This spring 63 produces strains in the whole cinematic chain and presses the rollers 55, 62 on to the cams 52, 53 respectively. If the cams have a suitable shape the spring suffers no elastic deformation. The relative position of the intermediate grippers 57 and the cylinder 51 is now securely defined because they are contained in one cinematic circle. A drive of this kind may be provided with

supplementary teeth the function of which will be described later on.

In Fig. 4 and in Fig. 5 which shows a developed side view of Fig. 4, the application of the new solution to a cinematic chain containing only uniformly rotating links is shown. The circle consists of six spur wheels 71 to 76 meshing with each other. One of the gear wheels 71 is fixed on the rotating part A which is to be brought into exact interrelation with a second part B fixed to the gear wheel 74. The whole circle is driven by a pinion 77 meshing with the gear wheel 71. If the wheels 75, 76 are omitted and the whole runs without load then the gear wheel 74 and the part B connected to it will not be in exact relation to the part A in consequence of the play between the gear teeth. The gear wheels 75. 76 alone do not improve this condition but a spring which gives tension to the whole circle must be incorporated at some suitable point. In the embodiment shown in Fig. 5 of the drawings, the gear wheel 76 of Fig. 4 is represented as two gear wheels 76', 76'' either of which is loose on their common shaft 79'. Between lugs 80', 80'' is inserted a spring 78 which urges the two gear wheels in opposite directions. Instead of one gear wheel 73 two wheels 73', 73'' are provided so that the wheel 72 is in the same plane as the wheel 71.

The arrows in Fig. 4 show, that the spring 78 tends to turn one part of the gear wheels 71 to 76 in one direction, and the other part of the wheels in the opposite direction. As far as the play in the teeth allows all wheels except the first driven wheel 71 can follow the pressure of the spring, so that finally the wheel 71 is clamped between two forces compensating each other whereby the whole cinematic circle is under tension and all meshing teeth under pressure. When the device is rotating the pressure works in one part of the circle in the sense of the rotation and in the other part against the rotation so that eventually the driving wheel receives from the spring as much energy as is taken from it.

As shown by the arrows the pressure on the teeth of the wheels 71 and 75 exerted by the spring inserted between the wheels 76', 76'' has an outward direction at the meshing point. It is possible therefore to apply a device other than the spring rotating with the wheels 76', 76'' but giving rise to the same effect. This equivalent device is shown in Fig. 6 in which only that part of the cinematic circle is shown which contains the spring. The shaft 79'' of a single wheel 76 is so supported in a sliding bearing that it can be pressed outwards in the guides 79''' by a spring 78' which does not rotate, but gears against a fixed part 80''' of the machine.

The two possibilities of rotating and non-rotating springs exist in all forms of application of the invention to devices rotating either with constant or with variable speed. The number of the meshing wheels is of no influence. Instead of gear wheels the circle may contain bevel gears or helical gears or even levers or the like. The number of parts to be brought into exact interrelation may be more than two. Such parts can for example be connected with the wheels 72, 73, 75 and so on in Fig. 4, and similarly further exactly driven parts can be attached in Fig. 3.

Within wide limits it is permissible to insert the drive or the spring at any part of the cinematic circle. The limits are the following: As has been mentioned, by the driving part and the spring the circle is divided into two parts in one of which the spring constantly presses in the sense of the rotation and is driving and in the other one it acts against the rotation thus giving rise to load. (This is not so in oscillating devices, as there the spring has the effect of driving and giving rise to load alternatively in the same part of the cinematic circle.) In that part of the cinematic circle in which the spring is driving resistances which could arise must be overcome by the force of the spring; consequently it is possible that the spring is compressed and the teeth come out of contact, whereby the definite relation between the wheels concerned and the parts connected with them will be disturbed. In the other part of the circle, however, in which the spring is giving rise to load, the resistances are overcome by the pressure of one tooth against the other one; thus the exact relation is maintained. It is recommendable therefore to choose the disposition of the parts and the sense of the revolution so that the spring is pressing against the sense of the rotation on those parts which must be in exact interrelation and on all wheels inserted between them.

The only and sufficient condition for reaching this state resides in that within the cinematic circle the drive and the spring on the one hand and the two parts to be brought into exact relation on the other hand follow each other and the two pairs do not overlap; but it is admissible to apply either the spring or the drive immediately to one of the two parts to be brought into exact relation. From the foregoing it follows that the device shown in Fig. 4 ought to be driven in the sense indicated by the double arrow at the top of pinion 77. Deviations from the indicated mode are admissible, provided that the spring is strong enough to overcome all resistances which arise, as for instance in the case of oscillating devices where it must always overcome the resistance in one of the two directions of motion.

The foregoing fully applies to devices in which the two essential parts A and B (Fig. 4) do not turn proportionately, but are connected by a device which makes the two parts rotate at speeds deviating from such proportionateness. Such a speed varying device which could be inserted e. g. between the wheels 72 and 74 of the mechanism shown in Fig. 4, is shown in the two drawings Figs. 7 and 8. The gear wheels 72, 73', 73'' and 74 correspond to the parts designated by the same numbers in Figs. 4 and 5. Between the gears 73' and 73'' is a planetary bevel gearing. The planetary gear 81 turns loosely around a pivot 83 which is fixed to a bell crank lever 82. This bell crank lever rocks around a shaft 84 which carries the gear wheels 73', 73'', so that the planetary gear 81 when rocking keeps in contact with two bevel gears 85, 86 which are fixed to the spur wheels 73' and 73'' respectively. The rocking movement of the bell crank lever 82 is produced by a cam 87 and its counter-cam 88 on which the rollers 91, 92 run. These rollers are supported by a bell crank lever 82 by connecting rod 89.

If such a device, by which the speeds are varied, is inserted into the cinematic circle shown in Figs. 4 and 5, no other change has to be made (except that if the device is of the nature shown in Figs. 7 and 8 for instance, so that it changes the sense of the revolution, an intermediate gear must be inserted somewhere between the wheels 71 and 74, so that the changing of the sense of rotation is compensated for). Indeed the wheel 76' which now turns with varying speed has a

motion relative to the wheel 76'', but this relative motion between the two wheels is allowable in consequence of the elasticity of the spring 78 the effect of which on the whole circle is not interferred with, provided that the speed variation is not too considerable.

But if instead of the rotating spring a non-rotating spring of the type shown in Fig. 6 is inserted, the relative motion of the wheel 75 against wheel 71 moves the shaft 79'' inward and outward so that either the teeth would get out of mesh or would be jammed. It is necessary therefore to provide for the correct meshing of the wheels if a non-rotating spring is applied to a device with varying speed. This has been done in the mechanism shown in Fig. 9, in which the wheels 71 and 75 and the path on which the shaft 79'' of the wheel 76 moves are concentric. The wheel 71 here has internal gearing with which the pinion 76 supported by the bell crank lever 93 meshes and on which it rolls to and fro when the wheel 75 turns at a different speed from the wheel 71. The pinion 76 is constantly urged in one direction by the stationary spring 94.

If, as has been described, the spring is utilized to compensate for the differences of speed in the second part of the cinematic circle, it naturally must be inserted at that point where the difference of speed is produced. Furthermore it has to compensate for the whole relative displacement arising from the difference of speeds by its elastic deformation. These drawbacks i. e the need of inserting the spring in a definite link of the circle and the big elastic deformation, are done away with, if a second speed varying device is inserted which exactly compensates for the effect of the first speed varying device. In a cinematic circle containing two speed varying devices of this kind the spring may be inserted at any desired point and nevertheless it always acts between parts which have speeds equal to each other although their actual speed may vary. In spite of the varying speed the spring is thus subjected to a constant pressure, exactly as in a mechanism turning with constant speed.

The devices shown in Figs. 2 and 3 may be interpreted as examples of devices with varying speeds. The springs 40 or 63 are not deformed because the counter-cam 33 or 53 compensates for the variation of speed produced by the cam 32 or 42.

A rotating mechanism with two speed varying devices compensating each other is shown in Fig. 10. Between wheels 73' and 73'' the device shown in Figs. 7 and 8 is inserted. Between the wheels 76' and 76'' a second planetary bevel gearing of exactly the same type is inserted, the parts of which are designated by the same numbers as in Figs. 7 and 8, the letter *a* being added. The spring 78 is inserted in the wheel 75 as it was in the wheel 76 in Fig. 4. Provided that the cams 87*a*, 88*a* exactly compensate for the speed variation produced by the cams 87, 88 this spring 78 in wheel 75 now rotates with varying speed, but with constant pressure. It could be inserted at different other points. Thus it may be inserted between the two bell crank levers 82*a* and 90*a* instead of the connecting rod 89*a*. It would then move up and down without elastic deformation. The counter-cam 88*a* can be dispensed with as, independently of the location of the spring, the mechanism can be arranged so that the spring presses the roller 91*a* against cam 87*a*.

In Figs. 11 and 12 a mechanism is shown in which the rotating spring is arranged at that point where the difference of the speed is produced and nevertheless it acts without deformation although no planetary gear is applied. 101 is a stationary cam around which the wheel 102 turns either with constant or with varying speed. On the wheel 102 is fixed a pivot 103 on which a lever 104 is rocked by the roller 105 at its end rolling on the cam 101. In consequence of the rocking of lever 104 the other end of the lever receives a motion relative to the wheel 102. This motion is transferred by the spring 107 to a pivot 108 which is fixed to another spur wheel 109 concentric with the wheel 102. If the cam 101 is appropriately shaped the spring 107 is subjected to no deformation. If the spring is inserted at any other point of the cinematic circle the two pivots 106 and 108 may then be connected by a rigid connecting rod.

The cams 87*a*, 88*a*, 33, 53 or 101 which only serve as an abutment or stop for the undeformed spring need not be of high precision either in their shape or, if they rotate, in their drive, because any deviation is counterbalanced by the elasticity of the spring. If the deviation becomes considerable, one could call such mechanisms intermediate embodiments between those with an undeformed spring and those in which the whole difference of speed is compensated for by the elasticity of the spring.

A cinematic circle in which are inserted the supplementary teeth mentioned before operates exactly like a circle without such teeth during that time at which the supplementary teeth are not in mesh. In Fig. 13 is shown what happens with a mechanism similar to that shown in Fig. 3 for instance whilst the supplementary teeth are meshing. In this drawing all parts are designated with the same numbers as in Fig. 3 and the only difference between the two figures is that provided on the impression cylinder 51 is a tooth 64 and on the intermediate grippers 57 a tooth 65. These teeth are adjusted so that, if they mesh, the roller 55 is lifted slightly from the cam 52 and the parts 54, 55 and 56 of the cinematic circle are rendered idle. Thus a partial cinematic circle is produced which consists of the teeth 64, 65, intermediate grippers 57 and the parts 58 to 63. Within this new cinematic circle the spring 63 operates without deformation exactly as before and nevertheless gives pressure to the whole circle. The teeth 64, 65 are pressed against each other and the intermediate grippers have an absolutely exact position in relation to the impression cylinder 51 when the sheet is transferred.

In a similar way supplementary teeth may be applied in a rotary mechanism. In Fig. 4 for example the axes of the wheels 71 and 74 could be arranged so that the circumferences of these wheels touch each other and supplementary teeth could be provided on the shafts A and B, so that the wheels 72, 73 become idle and a partial cinematic circle containing the spring is produced which consists of the supplementary teeth and the wheels 74, 75, 76, 71.

Besides the partial circle containing the spring a second partial circle is always produced by the meshing of the supplementary teeth. This second circle, consisting in the case of Fig. 4 of the wheels 71, 72, 73, 74 and the supplementary teeth does not contain any spring and the danger of breakages therefore arises, precisely in the same way as if in Fig. 13 the roller 55 were prevented by a grooved cam from being lifted from the

cam 52. This danger can be avoided by dispensing with desmodromic drive in that part of the cinematic circle. Thus in the mechanism shown in Figs. 7 and 8 the counter-cam 88 could be omitted and instead thereof the roller 91 could be urged against the cam 87 by means of a spring attached to lever 90. In this case the mechanism would not be worse than that shown in Fig. 13, but the advantage of a desmodromic drive during the time in which the supplementary teeth do not act would be lost. If on the other hand it is desired to maintain the drive by cam and counter-cam and for this purpose a clearance is left between the cams in that part of the circumference at which the rollers are located whilst the supplementary teeth work (as would also have been possible in the mechanism shown in Fig. 13) the initial meshing of the supplementary teeth would become less accurate, because the clearance must begin before the teeth touch each other to avoid strains. A new disposition has therefore been provided by which a second spring is caused to operate only when the supplementary teeth are in contact, whilst during the rest of the time the drive is desmodromic. This device will be described later.

Figs. 14 to 16 show a constructional form of the drive of the intermediate grippers.

111 is the rotary impression cylinder of a printing press corresponding to 25 in Fig. 1. Its shaft 127 is supported by bearings in the side frames 113*a*, 113*b*. Secured to either end of the shaft are spur wheels 115*a*, 115*b*. With one of these spur wheels meshes the pinion 112 which drives the cylinder. Similarly to the parts 113, 115 designated here by *a* and *b* all the parts described in the following and designated by these letters are arranged twice so that the corresponding parts on each side of the machine are exactly the same; they are described therefore only once for the left-hand side of the Fig. 14. A spur wheel 116*a* meshes with the wheel 115*a*. It is fixed to a shaft 117*a* on which outside of the side frame is fixed another spur wheel 118*a*. This drives the wheels 119*a*, 120*a* and eventually the wheel 121*a* which turns loosely on the shaft 122 supported in the side frames and bearing the intermediate grippers 114 corresponding to 23 in Fig. 1. Fixed to the spur wheel 121*a* is a bevel gear 123*a* and fixed to the shaft 122 is a similar bevel gear 126*a*. With these two bevel gears meshes another bevel gear 125*a* supported by a rocking frame 124*a* which turns loosely around the shaft 122, so that the bevel gear 125*a* may act as a planetary wheel.

Whilst the same parts 115*b* to 126*b* on the right-hand side of the machine correspond to the parts 115*a* to 126*a* on the left-hand side, the parts connected with the frames 124*a* and 124*b* are different.

In Fig. 15 and on the left of Fig. 14 the drive of the frame 124*a* is shown. A cam 128 and a counter-cam 129 are fixed to the shaft 127 of the impression cylinder 111. On these cams run the rollers 130, 131 which are supported by two levers 133, 134 mounted loosely on a stationary pivot 132. The lever 130 is connected by the connecting rod 135 with the frame 134*a*. Each of the levers 133, 134 has a crooked extension. Provided in the extension 136 of the lever 133 is an adjustable set screw 137 which bears against the lever 134. The extension 138 of the lever 134 presses against the lever 133 by means of a spring 139.

On the other side of the machine as shown in Fig. 16 the frame 124*b* is connected by a tension spring 141 with a crank pivot 142 fixed to the shaft 127 of the impression cylinder 111.

Provided on the outer faces of the impression cylinder 111 on each side are teeth 143 which mesh with counter-teeth 144 fixed to the intermediate grippers 114 at that moment at which the registered sheet is transferred from the intermediate grippers to the impression cylinder.

As the intermediate grippers 114 rotate without interruption (although with varying speed) the sheet registered on the feeding table 145 is fed to the intermediate grippers by a feeding device 146 corresponding to 4 in Fig. 1. Fixed to this feeding device are teeth 147; when the sheet is transferred from the feeding device to the intermediate grippers, the teeth 147 mesh with the same teeth 144 on the intermediate grippers which also mesh with the teeth 143 on the impression cylinder. Of course, the relative position of the feeding device 146 with respect to the intermediate grippers 114 must also be definite. It is preferred therefore to use a device similar to that shown in Fig. 13.

The operation of the above-described construction is as follows. The uniform revolution of the shaft 122 of the intermediate grippers which would result if the frame 124*a* were stationary has superimposed on it an oscillatory movement by the cams 128, 129 by means of the planetary gear 125*a*. Hence the sum of the two movements is a varying speed without any rest. The shape of the cams 128, 129 is such that the speed of the intermediate grippers 114 at the two transferring points is exactly equal to the speed of the feeding device 146 and to the speed of the impression cylinder 111 respectively. In addition the shapes of the two cams correspond to each other in such a way that the lever 134 constantly presses against the adjustable set screw 137. Consequently the frame 124 is turned to the right in desmodromic manner by roller 130, lever 133 and connecting rod 135 whilst it is turned to the left in like manner by roller 131, lever 134, set screw 137, crooked arm 136, lever 133 and connecting rod 135.

Any play in the different wheels is eliminated by the one spring 141. It is easily to be seen that by means of the planetary gear 125*b* the spring gives rise to load on all wheels on the left-hand side of Fig. 14 and on the wheel 126*b* on the right-hand side. Thus the shaft 122 of the intermediate grippers is constantly urged against the sense of rotation. In consequence of the circular movement of the pivot 142, the lower end of the spring 141 moves very similarly to its upper end which goes up and down when the planetary gear 125*b* is moved to and fro corresponding to the difference in the speeds of the wheels 123*b* and 126*b*. Thus the spring 141 is subjected to a very small elastic deformation only.

Up till now the operation of the cinematic circle has been described, as it takes place during the whole time the supplementary teeth do not mesh. Evidently during this time the spring 139 is idle, so that the two levers 133, 134 could have been combined and the spring 139 and the set screw 137 dispensed with. But in consequence of the meshing of the supplementary teeth the whole cinematic circle is divided into two partial circles each of which operates in accordance with the present invention.

One of these partial circles, which contains the teeth 143, 144 and the mechanism on the right-hand side of the machine, is elastic in

consequence of the spring 141. This spring gives rise to load on the immediate drive of the intermediate grippers 114 from the cylinder 111, which is produced by the supplementary teeth 143, 144, just as it did before when the grippers were driven by the parts designated by *a*.

But the second part of the circle containing the parts *a* and the teeth 143, 144 is rigid and is subject to the danger of breakage if the supplementary teeth mesh with appreciable pressure. For this reason a certain clearance is given to the cams 128, 129 at that point where the rollers 130, 131 are located when the sheet is at the two transferring points from the feeding device to the intermediate grippers and from the intermediate grippers to the impression cylinder. In consequence of this clearance in the cams 128, 129, the spring 139 which bears against the crooked arm 138 and presses the roller 131 against the cam 129 is extended slightly and the set screw 137 ceases to bear against the lever 134. If now the teeth 144 are touched by the teeth 143 or 147 and moved a little in advance of that position to which the cams 128, 129 would have brought them, they lift the connecting rod 135 and the lever 133 a small distance and the spring 139 is compressed again. If the clearance in the cams is bigger than the amount by which the roller 130 on lever 133 is lifted by the contact of the supplementary teeth, the spring 139 for a moment acts in the left-hand partial circle exactly as the spring 141 does in the right-hand partial circle.

The fact that and the manner in which the mechanism described fulfills all postulates of a sheet feeding device is evident. Here some possible variations may be added.

If it is described to eliminate the whole clearance in the drive of frame 124*a*, a second connecting rod may be added as has been shown in Figs. 3 and 13, so that a complete cinematic circle is produced which contains not only the cams 128, 129, levers 133, 104 and spring 139, but also the connecting rod 135, frame 124*a* and the added connecting rod. The mechanism shown in Figs. 14 and 15 serves as an example of the application of the invention in such a way that the whole drive of the two parts which are to be brought into exact interrelation is not involved but only the clearance in a part of the drive is eliminated. This kind of drive is applicable if excessive play is not to be expected in the parts excluded from the cinematic circle.

It has been explained that it is possible in Figs. 7 and 8 to apply a speed varying device which is not desmodromic. In such a case the whole mechanism can be disposed so that the spring which gives rise to load on the whole circle, at the same time urges the roller 91 against the cam 87 and a separate spring for this purpose is not necessary.

As has been mentioned, more than two parts with exact interrelation may be incorporated in one cinematic circle. In this case the speed of these parts must not be proportional to each other. In Fig. 10 for example besides the speed varying device in wheel 73 a second and a third speed varying device could be incorporated in the wheels 74, 75 and the compensating speed varying device in wheel 76 then will have to compensate for the sum of the effects of the other speed varying devices.

A rotating spring can be incorporated in a part the shaft of which is movable. In Fig. 10 for example the planetary wheel 81*a* could be divided into two and a spring could be arranged between them in a similar way to the spring 78 in the wheel 75.

The mechanisms described may be used in machines other than printing presses wherever the precise mutual interdependence of two or more elements is to be produced.

What I claim is:

1. In combination with a sheet feeding device, an impression cylinder, means for imparting motion to the periphery of said cylinder, a set of grippers for transferring a sheet to said cylinder, means for feeding said sheet and transferring it to said grippers, and means for imparting to said grippers a continuous rotary movement of varying speed equal to the speed given to the sheet by the sheet feeding means at the point where the sheet is transferred to the grippers and equal to the peripheral speed of the cylinder at the point where the sheet is transferred from the grippers to the cylinder, the speed of said grippers between said feeding means and impression cylinder being at no time greater than the peripheral speed of the cylinder.

2. In combination with a sheet feeding device, an impression cylinder, means for imparting motion to the periphery of said cylinder, a set of grippers for transferring a sheet to said cylinder, means for feeding said sheet and transferring it to said grippers, means for imparting to said grippers a continuous rotary movement of varying speed equal to the speed given to the sheet by the sheet feeding means at the point where the sheet is transferred to the grippers and equal to the peripheral speed of the cylinder at the point where the sheet is transferred from the grippers to the cylinder, the speed of said grippers between said feeding means and impression cylinder being at no time greater than the peripheral speed of the cylinder, and means for driving said set of grippers comprising two cinematic chains connecting the impression cylinder with said set of grippers, one of said chains having a spring inserted therein for eliminating play from the drive.

3. A sheet feeding device according to claim 2, in which the spring is incorporated in one of the two chains between two rotating elements.

4. A sheet feeding device according to claim 2 in which the spring operates in one of the two gear chains on the movable shaft of a rotating element without participating in the rotation.

5. A sheet feeding device according to claim 2, in which within the cinematic circle constituted by the two chains the element which is driven and the spring on the one hand and the two elements which are to be brought into precise mutual interdependence on the other hand, for example, an impression cylinder and the rotating grippers, each constitute a pair of successive elements.

6. In combination with a sheet feeding device, an impression cylinder, means for imparting motion to the periphery of said cylinder, a set of grippers for transferring a sheet to said cylinder, means for feeding said sheet and transferring it to said grippers, means for imparting to said grippers a continuous rotary movement of varying speed equal to the speed given to the sheet by the sheet feeding means at the point where the sheet is transferred to the grippers and equal to the peripheral speed of the cylinder at the point where the sheet is transferred from the grippers to the cylinder, the speed of said grippers between said feeding

means and impression cylinder being at no time greater than the peripheral speed of the cylinder, and means for driving said set of grippers comprising two cinematic chains connecting the impression cylinder with said set of grippers, one of said chains having a spring inserted therein for eliminating play from the drive, the elements comprising the impression cylinder and grippers which are to be brought into precise mutual interdependence of motion on the one hand and the elements comprising the driven element and the spring on the other hand constituting a cinematic circle in which each pair of elements are arranged successively, said spring acting against the direction of rotation of the cinematic circle in the part of this circle containing the impression cylinder and grippers.

7. A sheet feeding device according to claim 2 in which each of the two cinematic chains driving the grippers contains a gear for altering the speed and the alterations in speed produced thereby ignoring the possibility of elastic distortion of the spring are equal or substantially equal so that the spring is subjected to constant or substantially constant tension.

8. A sheet feeding device according to claim 2 in which only one of the two cinematic chains driving the gripper means comprises a gear for altering the speed and the alterations in speed produced thereby are balanced out by the alterations in configuration of the spring in the other cinematic chain.

9. A sheet feeding device according to claim 2 in which a reciprocatory member of the driving mechanism for the rotary grippers is connected with an element of the machine from which its drive is derived by means of two independent gearings of which one is rendered resilient by means of an incorporated spring, the speeds produced by the two gearings, ignoring the possibility of distortion of the spring, being equal or substantially equal so that the spring is subjected to constant or substantially constant tension.

10. A sheet feeding device according to claim 2 in which one of the two cinematic chains interconnecting the two elements which are to be brought into precise interdependence, for example, the impression cylinder and the rotating grippers, is temporarily replaced in known manner by elements coming into direct contact, for example, by individual teeth, the operative connection between the parts temporarily coming into contact being produced by the spring in the other cinematic chain.

11. In combination with a sheet feeding device, an impression cylinder, means for imparting motion to the periphery of said cylinder, a set of grippers for transferring a sheet to said cylinder, means for feeding said sheet and transferring it to said grippers, means for imparting to said grippers a continuous rotary movement of varying speed equal to the speed given to the sheet by the sheet feeding means at the point where the sheet is transferred to the grippers and equal to the peripheral speed of the cylinder at the point where the sheet is transferred from the grippers to the cylinder, the speed of said grippers between said feeding means and impression cylinder being at no time greater than the peripheral speed of the cylinder, and means for driving said set of grippers comprising two cinematic chains connecting the impression cylinder with said set of grippers, and individual teeth for contacting each other for temporarily replacing one of said cinematic chains, the spring of the one cinematic chain establishing contact between said teeth, the other cinematic chain which is normally non-resilient having a spring and means for rendering said spring operative only during the contact of said teeth, said means comprising a pair of cam controlled levers having abutments normally contacting each other and a pair of cams, said cams having suitable configuration for breaking the contact between said abutments, and spring means between said levers permitting relative movement.

12. In sheet feeding mechanism, the combination of a rotary sheet feeding element, transfer means for conveying sheets to said element, a moving sheet carrier adapted to receive sheets from said element, and means for imparting to said element varying, continuous rotary motion, the velocity of said element, during the transfer cycle of a sheet from said transfer means to said element and from said element to said carrier, being never higher than the surface speed of said carrier.

13. In sheet feeding mechanism, the combination of a rotary sheet feeding element, transfer means for conveying sheets to said element, a moving sheet carrier adapted to receive sheets from said element, and means including two cinematic chains for imparting to said element varying, continuous rotary motion, the velocity of said element, during the transfer cycle of a sheet from said transfer means to said element and from said element to said carrier, being never higher than the surface speed of said carrier.

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