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"APPARATUS FOR CONTROLLING A PULSE GENERATOR"

This invention relates to an apparatus for controlling a pulse generator, such as a pulse generator provided in a printer for generating a printing timing pulse.

5 There is a printer which comprises a platen having a plurality of longitudinally extending projections on its outer peripheral surface, and a printing hammer which is movable longitudinally of the platen. The motion of the printing hammer is controlled by a printing timing pulse synchronized with the position of a particular projection
10 on the platen. In order to form an accurately positioned dot, it is necessary to control the phase of any such printing timing pulse. The pulse is generated by an optical sensor which cooperates with detecting holes in a rotary detecting plate. The sensor is movable to a predetermined extent about
15 the centre of the detecting plate. The adjustment of the sensor is effected by loosening a screw for the sensor, displacing the sensor along a guide and tightening the screw again. The necessity for loosening the screw and tightening it again requires a lot of time for the
20 adjustment of the sensor, and makes it a very inefficient job.

A large space is required for installing the optical sensor movably around the outer periphery of the rotary detecting plate, and the entire apparatus is, therefore, very large. The sensor is movable only to a limited extent, and sometimes fails to control the printing position.

In any such event, it is necessary to change the engagement of a motor pinion, a train of reduction gears and a platen gear. This change requires the use of special jigs, and is, therefore, a costly job. Moreover, it is a complicated job to establish a predetermined relationship between the projections on the platen and the detecting holes in the rotary detecting plate.

According to the present invention, there is provided an apparatus for controlling a pulse generator, said apparatus comprising a sensor; a rotary plate which is provided with locating means such that, in operation, the sensor generates a pulse when the locating means is in a predetermined position; a rotary member comprising an indexing gear which faces one side of said plate, the plate being rotatably supported on a shaft portion of said rotary member; a plurality of indexing pins provided on said one side of said plate and engageable with teeth on said indexing gear, said indexing pins being disengageable from said teeth and engageable with different teeth on said indexing gear by rotation of said plate relative to said indexing gear; and a spring urging said plate towards engagement with said indexing

gear so that, during said engagement, rotation of the rotary member is transmitted to said plate.

Thus the apparatus of the present invention enables easy and accurate control of a pulse generator, e.g. of a pulse generator as used in a printer. The provision of the indexing gear facilitates fine control. Moreover, the apparatus of the present invention may be small and compact in construction so as to reduce the space required for the installation of the pulse generator as a whole.

The sensor is preferably an optical sensor which is stationary, the plate being rotatable so as to control, for example, a printing position.

The apparatus of the present invention may facilitate the control of, for example, the printing position over a wide range without any particular limitation. Moreover, it may be so made as to be less costly than any similar apparatus known in the art.

Preferably, said plate has a plurality of detecting slits having an angular pitch θ_1 , which differs from the angular pitch θ_2 of said teeth on said indexing gear. Preferably also the value of

$$\frac{\theta_1}{(\theta_1 - \theta_2)}$$
 is an integer.

The indexing gear may have a plurality of pins which engage with the teeth of a motor pinion of a motor which is arranged to drive the indexing gear.

The invention also comprises a pulse generator provided with the said apparatus.

Additionally, the invention comprises a printer provided with the said pulse generator, said pulse generator being arranged to generate printing timing pulses.

The printer may comprise a platen, whose external circumference is provided with a plurality of projections, and a printing hammer, actuable by said printing timing pulses, to effect dot printing on material interposed between the platen and the printing hammer. Thus the said projections may be spaced apart from each other both angularly and axially of the platen, there being means for rotating the platen and for moving the printing hammer axially of the platen.

The printing hammer may be inclined at an angle of $90^\circ - \theta$ to the axial direction of the platen, where $\theta = \tan^{-1} \frac{\alpha}{\beta}$ α and β being respectively the axial and circumferential distances between adjacent projections.

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

Figure 1 is a fragmentary side elevational view of a printer which may be provided with apparatus according to the present invention;

Figure 2 is a developed view of a platen which forms part of the printer of Figure 1, Figure 2 illustrating the printing operation;

Figure 3 is a cross-sectional view of a printing hammer which forms part of the printer of Figure 1;

Figure 4 is a view showing a signal from an optical sensor which forms part of an apparatus according to the present invention as shown in Figures 5-8;

Figure 5 is a top plan view of the said apparatus according to the present invention;

Figure 6 is a fragmentary enlarged front elevational view of the said apparatus according to the present invention;

Figure 7 is a sectional view taken along the line VII-VII of Figure 6;

Figure 8 is an exploded perspective view of the said apparatus according to the present invention; and

Figure 9 is a diagrammatic view illustrating the control of the printing position in a printer as shown in Figures 1-3.

In Figure 1 there is shown a printer provided with a platen 21 which has eighteen projections on its outer peripheral surface, as shown at 1a to 1r, the projections 1a to 1r being both angularly and longitudinally (i.e. axially) spaced apart. A sheet of paper 22 and an ink ribbon 23 are disposed between the platen 21 and a printing hammer 24. The platen 21 is continuously rotatable, as described in greater detail below, in the direction of an arrow 15 in Figure 1. The printing hammer 24 is continuously movable (by means not shown) longitudinally of the platen 21 to bring it successively to the various positions in which it may be moved, as indicated by the double-headed arrow 16, so as to strike against the platen 21. Such striking movement of the printing hammer 24 is synchronous with a timing pulse transmitted to the printing hammer 24 during its longitudinal movement, whereby to print a dot in conjunction with a particular projection on the platen 21. The projection 1a on the platen 21 is such that when the printing hammer 24 strikes successively against it, there may be printed eight dots in a vertical line in accordance with the timing pulses transmitted successively at locations (1) and (8) during the angular movement of the projection 1a with the rotation of the platen 21 through these locations, as shown in Figures 1 and 2. On further rotation of the platen 21, the projection 1b arrives at location (1), and the printing

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hammer 24 is adapted to print dots in another line. The printing hammer 24 is inclined as shown in Figure 3 at an angle of $90^\circ - \theta$ to the axial direction, and the angle θ of its inclination is expressed as follows:

5 $\theta = \tan^{-1} \frac{\alpha}{\beta}$

in which α stands for the axial distance between dots longitudinally of the platen 21, and β stands for the circumferential distance between every two adjoining projections on the platen 21.

10 Figure 2 shows the letter "F" printed by way of example. A drive signal is transmitted to the printing hammer 24 at locations (2) to (8), and seven dots are printed by the projections 1a. Two dots, all at locations (5) and (8), are printed by each of the projections 1b to 1d, and a
15 single dot is printed by the projection 1e at location (8) to complete the formation of the letter "F". The projections 1f and 1g do not print any dot, but leave a space between two adjoining letters. Likewise, the letter "J" is printed by the projections 1h, 1i and 1j, as shown in
20 Figure 2.

Referring to Figures 5 and 7, a motor 25 for driving the platen 21 has an output shaft 26 projecting through a hole 28a in a mounting plate 28, and a motor pinion 27 is secured to the shaft 26. A reduction gear 29, mounted on
25 a shaft 29b, is engaged with the motor pinion 27. The platen 21 has a shaft 13 to which a platen gear 14 is secured. The

platen gear 14 is engaged with a gear 29a which is mounted on the shaft 29b so as to rotate with and be coaxial with the reduction gear 29. The rotation of the motor pinion 27 is, therefore, transmitted to drive the platen 21. The motor pinion 27 has a shaft portion 27a on which an indexing gear 10c is rotatably supported. The indexing gear 10c has a shaft portion 10a on which a rotary detecting plate 11 is rotatably supported so that the indexing gear 10c faces one side of the detecting plate 11. A spring 12 is secured to the shaft portion 27a of the motor pinion 27 to hold the rotary detecting plate 11 resiliently against the indexing gear 10c.

The indexing gear 10c can alternatively be formed as an integral part of the motor pinion 27.

The indexing gear 10c has thirty teeth in the example shown in the drawings. The rotary detecting plate 11 has adjacent to its outer periphery a plurality of equally spaced apart detecting holes 11a forming a circle, as shown in Figure 6. The number of the detecting holes 11a is equal to the number of dots for each row multiplied by an integer, but less two. In the example shown, the plate 11 has thirty eight holes 11a, and a space 11b occupying two holes is provided in a circular array of the holes 11a. Each hole 11a defines a slit for determining the printing timing for a dot. An optical sensor 13 is secured to the mounting

plate 28, and includes a light-emitting element, not shown, and a light-receiving element, not shown, but disposed on the opposite side of the rotary detecting plate 11 from the light-emitting element.

5 The optical sensor 13 provides a series of signals, as shown in Figure 4, through ten detecting holes 11a for a vertical line of dots at locations (1) to (10) for a projection on the platen 21 on rotation of the latter. If ten holes starting with 11a' in Figure 6 are, for example, 10 used for detection at locations (1) to (10) for the projection 1a, ten holes beginning with 11a" are used for detection at locations (1) to (10) for the projection 1b. The printing hammer 24 is smaller than the circumferential distance β between every two adjoining projections so as 15 to ensure that it does not effect printing in conjunction with two projections simultaneously. Eight holes define printing timing, and two holes define stop timing.

 The rotary detecting plate 11 has a pair of indexing pins 11c as shown in Figure 8. The indexing pins 11c 20 are engageable with the teeth on the indexing gear 10c. The spring 12 holds the detecting plate 11 against the indexing gear 10c to keep the indexing pins 11c engaged with the teeth on the indexing gear 10c so that rotation may be transmitted to the detecting plate 11. If the detecting 25 plate 11 is detached from the indexing gear 10c against

the force of the spring 12, however, it is possible to adjust the position of the detecting plate 11 relative to the indexing gear 10c. The indexing gear 10c has a plurality of pins 10b engaged with the teeth of the motor pinion 27 so that the rotation of the motor may be transmitted to the indexing gear 10c. The pins 10b are not disengageable from the pinion 27, since the spring 12 is disposed in close proximity to the end of the shaft portion 10a of the indexing gear 10c.

In the example shown, the indexing gear 10c has thirty teeth having an angular pitch θ_2 of 12° , and the rotary detecting plate 11 has thirty eight detecting holes or slits 11a having an angular pitch θ_1 of 9° except for the portion 11b. It follows, therefore, that if the engagement of the indexing pins 11c with the indexing gear 10c is shifted by one tooth on the indexing gear 10c, the position of the slits 11a is shifted by an amount equal to $\frac{40}{30}$ dots relative to the optical sensor 13 to effect timing control. This means that each tooth on the indexing gear 10c enables adjustment corresponding to $\frac{4}{3}$ dots. Each projection on the platen 21 enables the printing of ten dots. Ten dots are equal to $(\frac{4}{3} \text{ dots} \times 7 \text{ teeth}) + \frac{2}{3} \text{ dot}$. This means that seven teeth enable adjustment for each projection (i.e. for a vertical line of dots) at a location retracted by $\frac{2}{3}$ dot. This difference of $\frac{2}{3}$ dot is corrected

by the succeeding eight teeth, since seven plus eight teeth are equal to twenty dots ($\frac{4}{3}$ dots x 15 teeth). This is the number of the dots printed by two projections. Thus, the apparatus enables fine control of the printing position by an amount Δd of $\frac{2}{3}$ dot. Finer control is possible if the pitch of the teeth on the indexing gear 10c and the pitch of the slits 11a in the detecting plate 11 are appropriately altered.

The control of the printing position is shown by way of example in Figure 9. In Figure 9, the dimension L shows the area in which printing is possible by the printing hammer 24. If a particular projection on the platen 21 is located within the printable area L, the printing of a dot is possible. It is important to ascertain first of all the relation between the projections and the printing timing. When the slit 11a' of the detecting plate 11 has been detected by the sensor 13, a drive signal is applied to enable printing at location (1) of the projection 1a. If, for example, a dot A is printed at the projection 1r as shown at (a) in Figure 9, the projection 1r still stays within the printable area L, and location (1) for the projection 1a is still outside the area L. The detecting plate 11 is moved away from the indexing gear 10c against the force of the spring 12 so that the indexing pins 11c may be disengaged from teeth on the indexing gear 10c. The plate 11 is rotated

back for a distance corresponding to four teeth on the indexing gear $10c$ and the indexing pins $11c$ are engaged with the indexing gear $10c$ again. The four teeth correspond to $5\frac{1}{3}$ dots. If a drive signal is applied upon detection of the slit $11a'$ by the sensor 13, a dot B is printed at the projection $1a$ as shown at (b) in Figure 9. One-third of a dot C is, however, not printed at location (8) of the projection $1a$. Therefore, the plate 11 is disengaged from the indexing gear $10c$ again, rotated back by a distance corresponding to seven teeth on the indexing gear $10c$, and engaged with the indexing gear $10c$ again. The seven teeth correspond to $9\frac{1}{3}$ dots. If printing is effected upon detection of the slit $11a'$ by the sensor 13, a dot D is printed at the projection $1b$ as shown at (c) in Figure 9. This means the achievement of fine control for the printing position by a distance which is shown at Δd in Figure 9. The dot D has been moved back from the dot B by a distance corresponding to $\frac{2}{3}$ dot. A dot E is printed at location (8) of the projection $1b$. It has been moved back from the dot C by a distance corresponding to $\frac{2}{3}$ dot and stays completely within the printable area L.

The pinion 27 on the motor shaft 26 can itself be used as an indexing gear if it has a sufficiently large number of teeth. Moreover, there is no problem, even if the angular pitch θ_2 of the teeth on the indexing

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gear 10c is smaller than the angular pitch θ_1 of the slits
in the detecting plate 11.

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C L A I M S

1. An apparatus for controlling a pulse generator,
said apparatus comprising a sensor; a rotary plate which is
provided with locating means such that, in operation, the sensor
generates a pulse when the locating means is in a
predetermined position; a rotary member comprising an indexing
gear which faces one side of said plate, the plate being
rotatably supported on a shaft portion of said rotary
member; a plurality of indexing pins provided on said one
side of said plate and engageable with teeth on said
indexing gear, said indexing pins being disengageable from
said teeth and engageable with different teeth on said
indexing gear by rotation of said plate relative to said
indexing gear; and a spring urging said plate towards
engagement with said indexing gear so that, during said
engagement, rotation of the rotary member is transmitted
to said plate.

2. An apparatus as claimed in claim 1 in which the
sensor is an optical sensor.

3. An apparatus as claimed in claim 1 or 2 wherein
said plate has a plurality of slits having an angular
pitch θ_1 which differs from the angular pitch
 θ_2 of said teeth on said indexing gear.

4. An apparatus as claimed in claim 3, wherein the
value of $\frac{\theta_1}{(\theta_1 - \theta_2)}$ is an integer.



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5. An apparatus as claimed in any preceding claim in which the indexing gear has a plurality of pins which engage with the teeth of a motor pinion of a motor which is arranged to drive the indexing gear.

5 6. An apparatus for controlling a pulse generator substantially as hereinbefore described with reference to and as shown in Figures 5-8.

7. A pulse generator provided with an apparatus as claimed in any preceding claim.

10 8. A printer provided with a pulse generator as claimed in claim 7, said pulse generator being arranged to generate printing timing pulses.

15 9. A printer as claimed in claim 8 comprising a platen, whose external circumference is provided with a plurality of projections, and a printing hammer, actuable by said printing timing pulses, to effect dot printing on material interposed between the platen and the printing hammer.

20 10. A printer as claimed in claim 9 in which the said projections are spaced apart from each other both angularly and axially of the platen, there being means for rotating the platen and for moving the printing hammer axially of the platen.



11. A printer as claimed in claim 10 in which the printing hammer is inclined at an angle of $90^\circ - \theta$ to the axial direction of the platen, where

$\theta = \tan^{-1} \frac{\alpha}{\beta}$, α and β being respectively the axial and circumferential distances between adjacent projections.

12. A printer, provided with apparatus as claimed in claim 1 for controlling a pulse generator, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.
