July 9, 1957 C. C. ECKEL ET AL 2,798,976

TIMING SIGNAL GENERATOR

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Fig. 1.

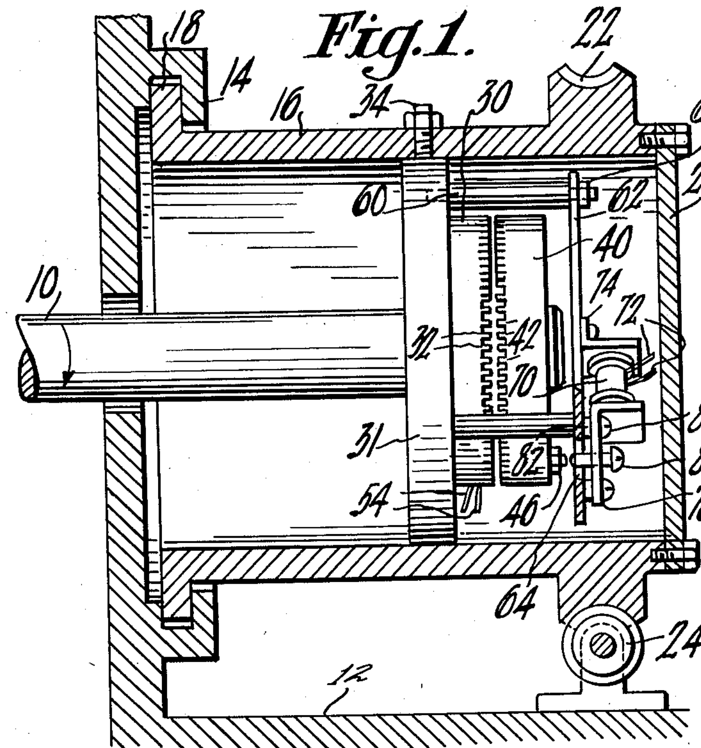


Fig. 4.

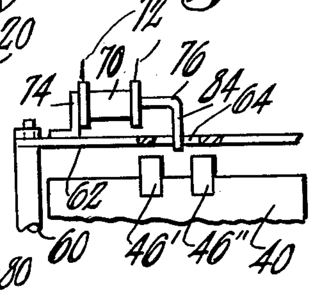


Fig. 2.

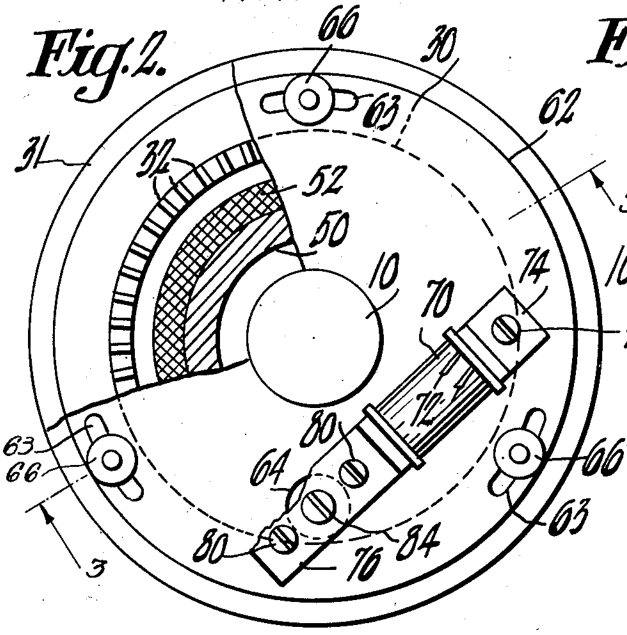
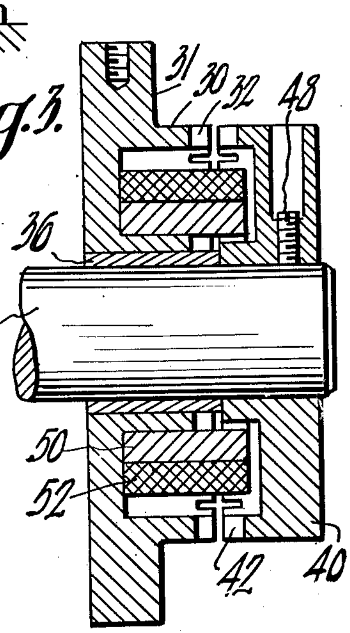


Fig. 3.



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TIMING SIGNAL GENERATOR

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The terminal fifteen years of the term of patent to be granted has been disclaimed

3 Claims. (Cl. 310—155)

This invention relates to signal generating devices, and particularly to devices for generating timing and index signals for control functions.

Signal generators are often used for timing and control. Some modern high-speed printers, for example, print by rapidly striking hammers against continuously rotating type wheels. Such printers require timed signals to control the actuation of the print hammers, and to mark the start of each print wheel revolution. Electro-mechanical signal generators for timing purposes are usually subject to contact bounce and excessive wear. Although high-speed electronic devices may be employed, a more economical and simple device than these high-speed electronic devices is desirable for most electro-mechanical systems.

Therefore, it is an object of this invention to provide an improved device for generating timing signals, which device is characterized by economical and reliable operation.

Another object of this invention is to provide an improved timing signal generator providing greater signal strength and improved signal definition over the devices of the prior art.

A further object of this invention is to provide an improved timing and index pulse generator which is simpler, longer wearing, and more easily adjustable than devices heretofore known.

An index and timing signal generator provided in accordance with the present invention may employ a pair of hubs having opposed toothed surfaces for generating timing signals. One of the hubs may be stationary and the other rotated by an actuating shaft. A permanent magnet mounted between the hubs provides a flux path extending through both hubs and crossing the air gap between the opposed toothed surfaces. The size of the air gap varies with the position of the rotating hub. The resultant changes of flux, as the moving hub rotates, may be detected to provide timing signals. Index signals may be provided by employing a secondary flux path structure operating with the rotating hub. A change of secondary flux occurs once each revolution and is detected to provide the desired index signal. The timing and index signals may be advanced or retarded with respect to the actuating shaft by simple adjustments of normally stationary parts of the mechanism.

The novel features of the invention, as well as the invention itself, both as to its organization and method of operation, will best be understood from the following description, when read in connection with the accompanying drawing, in which like reference numerals refer to like parts, and in which:

Fig. 1 is a side elevation, partly in section, of a device for practicing the invention including a signal generator within a rotatable housing;

Fig. 2 is an end view, partly broken away, of the timing signal generator of Fig. 1;

Fig. 3 is a side section of the timing signal generator,

taken along the line 3—3 of Fig. 2, in the direction of the appended arrows; and

Fig. 4 is a partial, detailed, view of an alternative arrangement of one portion of the signal generator of Fig. 1.

Referring to Fig. 1, an arrangement for practicing the invention may be employed with a continuously rotating shaft 10 such as is employed with a modern high-speed printer (not shown). The arrangement may be mounted on the base structure 12 of the printer, about the free end of the actuating shaft 10. The printer base structure 12 may include a circumferential hook portion 14 for receiving and retaining a housing 16 for the signal generator arrangement. A peripheral flange 18 on the housing 16 may fit within the hook portion 14 of the base 12. The fit between the flange 18 and the base hook portion 14 is such that the housing 16 may be rotated manually, but is not loose enough to move under normal operating forces and vibrations. The housing 16 comprises a cylinder having an end cap member 20. A worm wheel 22 is provided on a circumference of the cylindrical portion of the housing 16.

A worm gear 24, mating with and driving the worm wheel 22 portion of the housing 16, is mounted in the base structure 12. The worm gear 24 may be manually adjusted by a terminal knob or other means (not shown).

The signal generator is mounted within the housing 16. A stationary hub 30 having a flange base 31 and a ring of circumferential teeth 32 is mounted concentrically about the printer shaft 10. Set screws 34 extending through the housing 16 hold the hub 30 at different points on the flange base 31. Between the stationary hub 30 and the printer shaft 10 (refer also to Fig. 3) is a non-magnetic bearing 36. A rotating hub 40 having a ring of circumferential teeth 42 is fixed by a set screw 48 to the end of the printer shaft 10. The teeth 32 and 42 on the hubs 30 and 40, respectively, are opposed to each other, but spaced apart. The teeth 32 and 42 are of similar size and shape, each hub 30 or 40 having the same number. The hubs 30 and 40 are of magnetic material.

A toroidal permanent magnet 50 having an outer winding 52 is mounted against the stationary hub 30, within the aperture defined by the two hubs 30 and 40 and the printer shaft 10. Terminals 54 from the winding 52 extend through an aperture in the stationary hub 30. The flux generated by the magnet 50 describes a path extending through the stationary hub 30, across the air gap between the opposing teeth 32 and 42, and through the rotating hub 40 to the magnet 50. An indexing projection 46, here shown as a threaded screw, is mounted in the rotating hub 40 on the side away from the magnet 50. A set screw 48 is provided to hold the projection 46 at any selected position.

Three support posts 60 of magnetic material are mounted in the flange base 31 of the stationary hub 30. The support posts 60 are parallel to the printer shaft 10 and couple a magnetic end plate 62 to the stationary hub 30. The end plate 62 (best seen in Fig. 2) has a curved slot 63 for each of the support posts 60. A different set screw 66 threads into each of the different support posts 60 through the aligned curved slot 63 to hold the end plate 62. The end plate 62 also has an insulating aperture 64 at the radius of the projection 46 on the rotating hub 40.

A secondary pickup coil 70 is supported adjacent the end plate 62, on the side away from the hubs 30 and 40, by a pair of attached brackets 74 and 76. One bracket, termed a coupling bracket 74, holds one end of the secondary pickup coil 70 to the end plate 62. The other bracket, termed a spacing bracket 76, is so mounted on the end plate 62 as to hold the secondary pickup coil

70 magnetically separate from the end plate 62. Terminals 72 are provided for output from the secondary pickup coil 70. Both brackets 74, 76 are of magnetic material.

The coupling bracket 74 is held against the end plate 62 by a screw 78 threaded into the end plate 62. The spacing bracket 76 is mounted over the insulating aperture 64 in the end plate 62. Non-magnetic screws 80 fit through slots in the spacing bracket 76 and thread into the end plate 62. Non-magnetic washers 82 maintain a spaced relation between the spacing bracket 76 and the end plate 62. A magnetic member or secondary pickup projection, here a screw 84, moves in a mating thread in the spacing bracket 76, and in the line of the insulating aperture 64 in the end plate 62. When the secondary pickup projection 84 is in opposition to the indexing projection 46 on the rotating hub 40 a secondary flux path is provided. The secondary flux path extends from the toroidal magnet 50, through the rotating hub 40 to the indexing projection 46, across the air gap from the indexing projection 46 to the opposed secondary pickup projection 84, through the spacing bracket 76, the core of the secondary pickup coil 70, the coupling bracket 74, the end plate 62, support posts 60, and stationary hub 30 back to the magnet 50.

In operation, the printer shaft 10 and attached hub 40 are continuously rotating. The teeth 42 on the rotating hub 40 are like, in number and shape, the teeth 32 on the stationary hub 30. A flux emanating from the toroidal magnet 50 follows a primary path from the magnet 50, through the stationary hub 30, across the air gap between the opposed teeth 32, 42, and through the rotating hub 40 back to the magnet 50. The polarization of the flux is of course dependent upon the polarization of the magnet. The flux is greatest when the teeth 32, 42 are directly opposed to each other. The flux is least when the teeth on one hub are opposed to the spaces between the teeth on the other. The relationship exists, as is well known, because the permeability of the air gap is much less than that of the magnetic material. The changes of flux vary directly with the degree of alignment of the teeth 32, 42.

The changes of flux induce current in the winding 52 of the toroidal magnet. The direction of current flow is of course dependent upon the direction of the winding 52 with relation to the polarization of the magnet 50. The current, however, is sinusoidal, reflecting the increase and decrease in flux as the teeth 32, 42 go into and out of alignment. The voltage variation at the terminals 54 resulting from changes in the primary flux is likewise of a sinusoidal nature. These voltage variations comprise the desired timing signals. An extremely large differential in voltage may be provided with this arrangement. For example, with magnet 50 of approximately two and one half inches outer diameter, a rotation of approximately twenty r. p. s., and with fifty-five teeth in each set of teeth 32, 42, output signals of forty volts have been provided. Due to the symmetry of the arrangement and the absence of wearing parts the output signals are substantially constant in shape and amplitude.

An index signal is provided once in each revolution. The flux from the magnet 50 follows a secondary path through the stationary hub 30, the support posts 60, the end plate 62, the coupling bracket 74, the core of the secondary pickup coil 70, the spacing bracket 76, the secondary pickup projection 84, the indexing projection 46 and the rotating hub 40 back to the magnet 50. Some flux emanations exist between the rotating hub 40 in the end plate 62. These flux emanations are not, however, appreciable. A much greater secondary flux exists across the air gap between the indexing projection 46 and the secondary pickup projection 84 when these projections 46, 84 are opposed. Thus, once each revolution the secondary flux reaches a peak. At the same point in each revolution a current is induced in the secondary pickup coil 70 by the change in flux. A voltage variation, consisting of a single substantially sinusoidal variation, appears at the terminals 72 of the secondary pickup coil 70. With the structure given above the amplitude of the index signal may be approximately ten volts.

The structure provided is characterized by the ease and simplicity with which adjustments may be made. The timing and index signals may be advanced or retarded with respect to the printer shaft 10, and the strength of the index signal may be varied, within limits. It will be understood that, where desired, parts shown here as adjustable may be fixed to other parts, or fabricated as one segment of an integrated unit.

To advance or retard the timing signals with respect to the printer shaft 10 the worm gear 24 is turned manually. The worm wheel 22 and the housing 16 thus are rotated about the printer shaft 10 to a different angular position. Accordingly, the sets of teeth 32, 42 are opposed at different positions in relation to the print shaft 10. The timing signals, if used to control print hammers (not shown), for example, may be adjusted so that the print action results in full characters, printed in an even line.

The strength of the index signal may be varied by moving the indexing projection 46 and secondary pickup projection 84 closer together or further apart. Either or both of the screws 46 and 84 may be threaded in or out to open or close the air gap for the secondary flux path.

The secondary pickup projection 84 may also be adjusted in angular relation to the indexing projection 46. The set screws 66 holding the end plate 62 to the support posts 60 may be loosened, the end plate 62 turned in the curved slots 63, and the end plate 62 fastened in the desired position. In a high-speed printer the indexing signals may be employed to reset circuitry and to prepare for another printing cycle.

The wave variations derived at the terminals 54, 72 may be rectified to provide pulse signals for a control function. The amplitude of the signals may be varied within limits by changing the number of turns in the coils 52, 70. In some structures, however, stray flux paths may cause undesired signal variations on the terminals 72 of the secondary pickup 70. If the signal generator is closely abutted to a magnetic frame structure, and the shaft 10 is of magnetic material, for example, cross-talk sufficient to obscure the index signal may result. The index signal may be clearly distinguished, under these circumstances, by replacing the indexing projection 46 shown with a small permanent magnet. Properly positioned with regard to polarity, such an indexing projection acts in series with the toroidal magnet 50 to greatly increase the flux across the air gap in the secondary flux path.

A second way in which the effect of stray flux paths can be minimized is shown in Fig. 4. Two small permanent magnets 46′ and 46″ are mounted in the rotating hub 40 in place of the screw 46 shown in Fig. 1. The opposite poles of the magnets 46′, 46″ are placed together. Thus, on one side the flux path goes directly between the magnets 46′, 46″ through the magnetic material of the rotating hub 40. On the other side the flux path during the major portion of a revolution is between the magnets 46′, 46″ through a small localized area of the end plate 62. The flux does not change except when the magnets 46′, 46″ move into line with the insulating aperture 64 about the secondary pickup projection 84. As the magnets 46′, 46″ move into line with the secondary pickup projection 84 a flux path is provided from the projection 84 through the spacing bracket 76, the coil 70, the coupling bracket 74 and the end plate 62 back to one of the magnets 46′ or 46″. The momentary change of flux induces a current in the secondary pickup coil 70 and an output is provided on the terminals. In such an arrangement the secondary flux is not dependent on the primary flux. Therefore the support posts 60 may be of non-magnetic material.

Thus there has been provided a simple and economical timing and index signal generator. The arrangement is characterized by freedom from wear, output signals of uniform shape and high amplitude, and ease of adjustment.

What is claimed is:

1. A device for generating an index signal and a plurality of timing signals in adjustable relation to the position of a rotating shaft, said device comprising a base structure having an aperture for receiving a free end of said rotating shaft, a housing mounted on said base structure concentrically about said shaft free end, said housing being movable restrictedly about the axis of said shaft, means including a worm gear and worm wheel to move the housing about the shaft axis, a first hub mounted within said housing about and normal to said shaft axis, said first hub having a first ring of teeth concentrically spaced about said shaft axis in a plane normal to said shaft axis, a second hub mounted on and moving with said shaft, said second hub having a second ring of teeth opposing and in spaced apart relation to said first ring of teeth, a toroidal magnet fixed to said first hub between said first and second rings of teeth, first induction pickup means mounted between said rings of teeth, support posts coupled to said first hub and parallel to said shaft axis, a first projecting member mounted on said second hub on the side of said end plate and spaced at a radius from said shaft, an end plate substantially normal to the axis of said shaft and angularly movable on said support posts in spaced relation to said second hub, said end plate having an aperture at the radius of said first projecting member, a flux path member mounted on said end plate and extending over the aperture in said end plate, second induction pickup means coupled to said flux path member, and a second projecting member movably mounted on said flux path member in the line of said aperture for providing a controllable air gap with said first projecting member.

2. The invention as set forth in claim 1, wherein said first projecting member comprises a permanent magnet.

3. An index and timing signal generator for signalling incremental movements of a rotating shaft comprising a first hub mounted about and in fixed relation to said shaft, a second hub fixed to said shaft, said hubs being spaced apart and having opposed toothed surfaces about a given circumference normal to the axis of said shaft, means between said hubs in fixed relation to said first hub for generating a primary flux in a path extending through said hubs and said toothed surfaces, first output signalling means responsive to said primary flux, a pair of magnets on said second hub spaced apart from said toothed surfaces on the side away from said first hub, the opposite poles of said magnets being adjacent each other, means in fixed relation to said shaft and spaced apart from said second hub adjacent the path of movement of said pair of magnets to provide a secondary flux path between said pair of magnets at a given position of said second hub, and means coupled to said means to provide a secondary flux path to detect changes in the secondary flux.

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