Sept. 20, 1960

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2,953,651

IMPULSE GENERATOR

Filed July 15, 1957

2 Sheets-Sheet 1

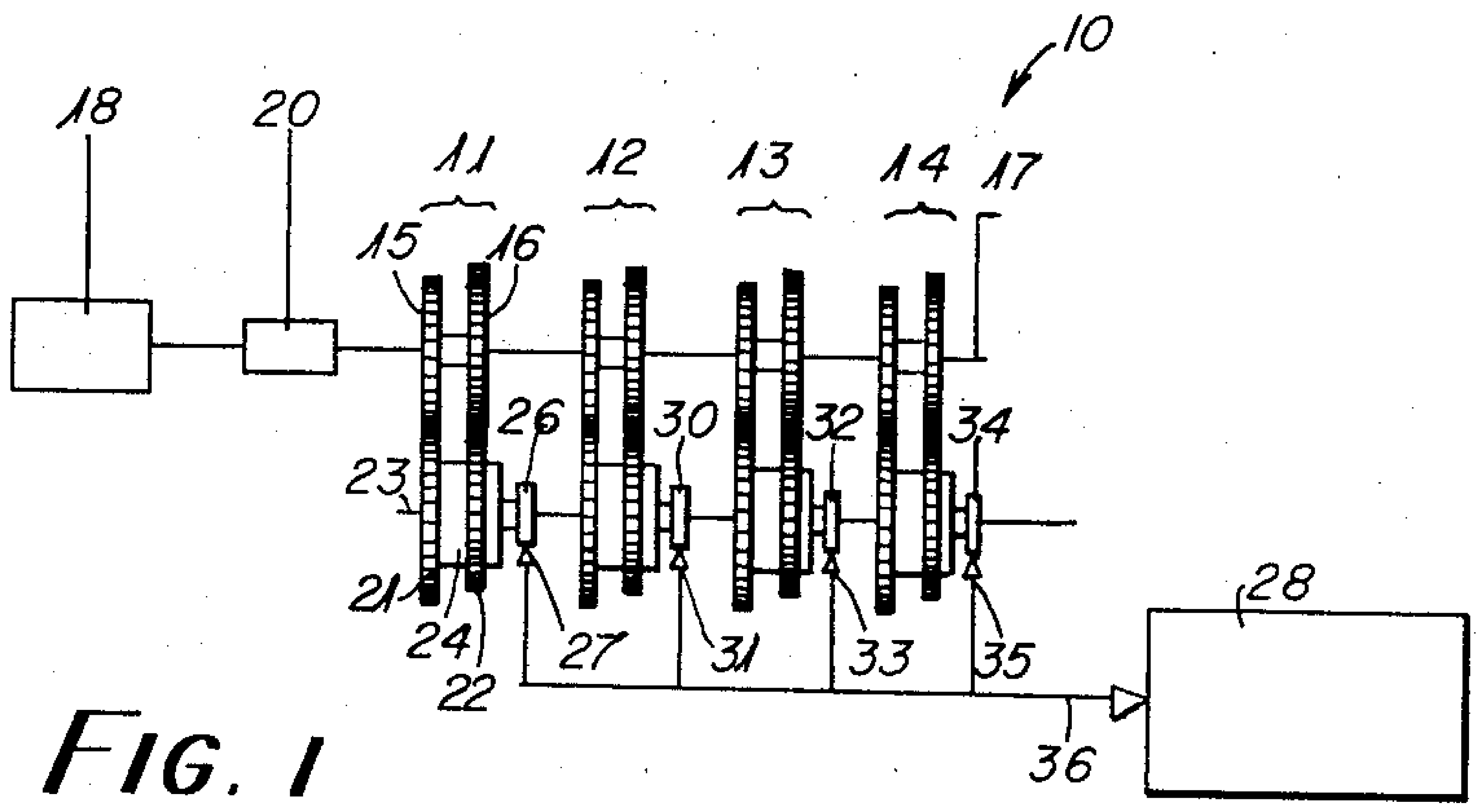

FIG. 1

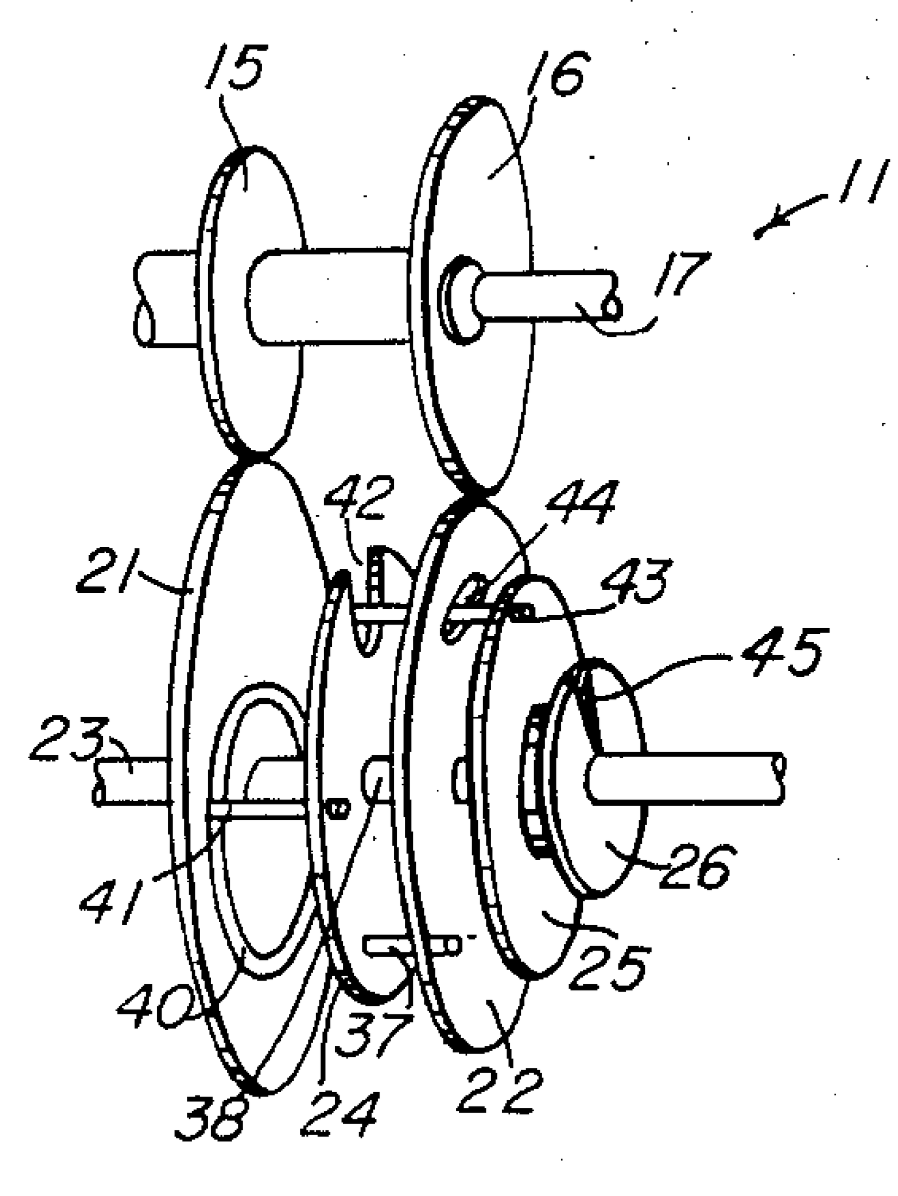

FIG. 2

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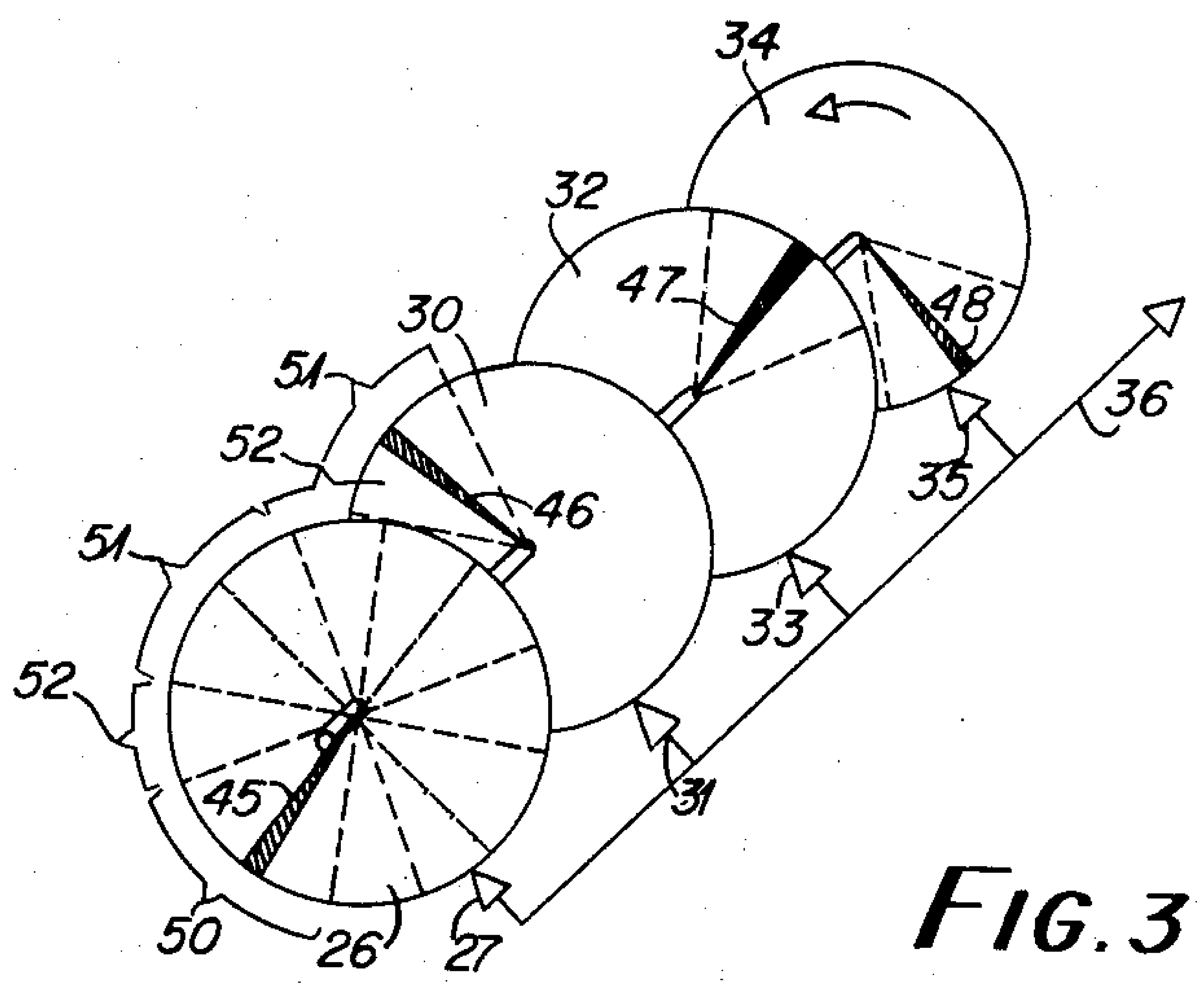

FIG. 3

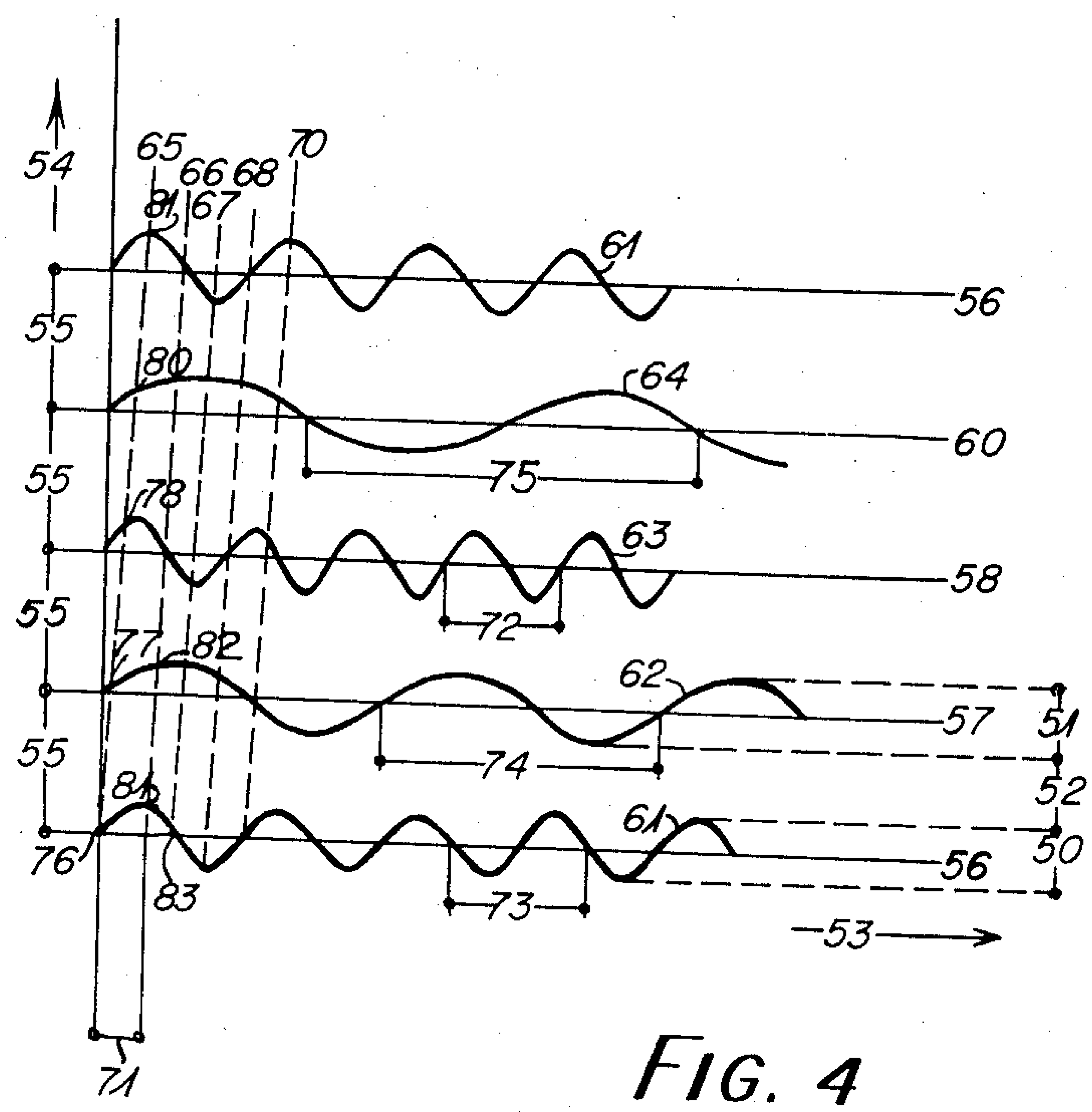

FIG. 4

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IMPULSE GENERATOR

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15 Claims. (Cl. 200—23)

This invention relates in general to an impulse control system and more particularly to an arrangement for generating control impulses which must follow one another in irregular succession but which should occur with the same average frequency when calculated over a relatively long period of time.

An example of the necessity for such a system is found in the textile industry, more especially on spinning machines for the manufacture of artificial yarn having a fluctuating denier or in twisting and winding installations for preventing flat area formation on winding bobbins.

In the manufacture of artificial yarn with suddenly changing denier such as, for example, slub rayon, one accepted procedure is to provide each spinneret with two spinning pumps, one of these pumps operating as the basic spinning pump for delivering a constant spinning solution for the normal denier, while the other pump operates as a supplementary spinning pump for supplying the additional spinning solution necessary to form the slubs. It is essential that these slub portions follow one another at irregular intervals, since otherwise there would be a tendency for patterns to occur on further working up of the yarn into fabric. On the other hand, however, there must always be the same number of slubs over a sufficiently large period of time in order to prevent steps in the patterned appearance of the finished woven or knitted fabrics.

The mechanism for actuating the supplementary spinning pump is controlled by impulses from an impulse generator, which impulses usually are fed through an amplifier system on the pump. It has been proposed, for example, to use radio-active emitters as impulse generators, these devices always emitting impulses which follow one another in irregular succession but which are of a sufficiently constant number over a relatively long period of time to prevent pattern occurrences. A disadvantage to this type of control, however, is the impossibility of arranging for the impulses to follow one another with a previously established minimum or maximum interval without destroying the equal distribution of impulses over a long period of time. It is also possible to utilize magnetic tapes for control of impulses fed to the supplementary pump actuating mechanism. The frequency with which this system cycles or repeats renders the same objectionable, however, for reasons discussed hereinabove.

A primary object of the present invention, therefore, is to provide an impulse control apparatus not having the disadvantages of known devices.

Another object of this invention is to provide an impulse generator capable of emitting control impulses at irregular intervals while maintaining the same number of impulses over successive long periods of operation.

A further object of this invention is to provide an apparatus for emitting control impulses which is capable of prolonged operation without re-cycling.

Still another object of this invention is to provide an apparatus for generating impulses of equal mean frequency but which follow one another in irregular succession.

The apparatus according to the present invention consists in a plurality of relatively rotatable contact discs driven from a common shaft through separate intermediate gear means. The contact discs rotate at the same mean speed and have contacts staggered relatively one to the other for triggering or controlling the impulse, and the intermediate gear means comprise interference discs which always allow each contact disc to oscillate on either side of the fundamental speed of revolution at an interference frequency which differs from that of the other discs.

The impulse generator according to this invention, therefore, consists in a plurality of contact discs, the number of which is chosen to correspond to the required or desired length of period, which discs are arranged in juxtaposition and which rotate at the same fundamental speed. Superimposed on the fundamental speed are larger or smaller oscillating interference frequencies, which cause a constant increase and decrease in the peripheral speed of the contact discs about the fundamental speed. Although each disc rotates at the same mean or fundamental speed, a return of the same impulse intervals emitted by the plurality of contact discs to a common impulse line occurs only after very long time intervals, since each disc oscillates with an interference frequency different from that of the other discs. By proper selection of relative interference frequency oscillations, re-cycling of the same impulse intervals will occur only after days or weeks of operation.

Other objects and advantages of the present invention will become apparent upon consideration of the following detailed description of a preferred embodiment, taken in conjunction with the accompanying drawings, wherein

Figure 1 is a schematic view showing an impulse generator having four contact discs and apparatus for utilizing the same;

Figure 2 is a perspective view, in slightly larger scale, showing one contact driving unit and the interference disc thereof;

Figure 3 is a diagrammatic view illustrating the coaction of the four contact discs shown in Figure 1; and

Figure 4 is a diagram showing the different intervals of successive impulses.

With attention now directed to Figure 1, the impulse generator indicated generally by reference numeral **10** consists of four contact driving units **11**, **12**, **13** and **14**. Each contact driving unit comprises a first drive gear **15** and a second drive gear **16** which has a comparatively small different number of teeth than the first drive gear. These gears are rigidly mounted in spaced relationship for rotation with drive shaft **17**. The four groups of drive gears **15**, **16**, only the first having been identified by reference numerals, are driven by motor **18** through transmission **20**. If desired, this transmission could be a conventional P.I.V. drive or any other type permitting adjustment of input-output speed.

All of the second drive gears **16** of the four contact drive units **11**, **12**, **13** and **14** have, for example, the same number of teeth, while the first drive gears **15** have a different number of teeth not only in relation to the second drive gears but also with respect one to the other. The gears **15**, **16**, which are mounted coaxially on shaft **17**, mesh with and therefore drive first driven gears **21** and second driven gears **22**, respectively, which driven gears are freely rotatable on an idler shaft **23** extending parallel to drive shaft **17**. Only one set of driven gears **21**, **22** has been identified by reference numeral, but it should be understood that one set of driven gears will be provided for each group of drive gears, four in the modification disclosed in the drawings. The four driven gears

21 have an equal number of teeth, as have the four driven gears 22. A gear 21 may or may not have the same number of teeth as a gear 22, depending on the impulse frequency desired.

Since the four contact driving units 11, 12, 13 and 14 are identical except for the different number of teeth in first drive gears 15, only one unit 11 will be discussed, attention being directed to Figure 2 for a detailed description thereof, it being understood that the same description applies to the other three units. As mentioned hereinabove, driven gears 21 and 22 are freely rotatable on idler shaft 23. Coaxially mounted intermediate the first driven gear 21 and the second driven gear 22 is an annular interference disc 24. The interference disc is connected not only to the first driven gear 21 but also to second driven gear 22, in a manner to be particularly described presently, and serves as a driving means for control disc 25, which control disc may in itself provide for the making and breaking of an electrial circuit, or which may be rigidly connected to a contact disc 26 provided for this purpose. Inasmuch as first and second driven gears 21, 22 travel at different peripheral speeds because of the difference in teeth of drive gears 15, 16, and since interference disc 24 and control disc 25 are driven by gears 21 22, it will be appreciated that the discs 24, 25 and 26 also must be freely rotatable with respect to idler shaft 23.

A control impulse derived from contact disc 26 in a manner to be explained hereinafter usually is transmitted by way of a pick-up device 27 to an amplifier system 28 at the spinning machine. This amplifier system, which is shown only schematically in Figure 1, may be of known construction and will not be discussed further herein. Operating in a similar manner, the contact driving unit 12 comprises a contact disc 30 and pickup device 31, the unit 13 comprising a contact disc 32 and pickup device 33 and the unit 14 comprising a contact disc 34 and pickup device 35. The contact discs are relatively arranged so that the control impulses derived therefrom occur in succession with a fixed phase displacement angle and all pass through the same collecting line 36 to the aforesaid amplifier system 28. Each impulse briefly sets into operation the supplementary spinning pump or pumps at the spinning machine (not shown).

With attention again directed to Figure 2 of the drawing, it will be seen that interference disc 24 is pivoted to second driven gear 22 by means of pin 37. The pivot pin 37 also serves as the center of curvature of an arcuate slot 38 centrally disposed in disc 24 and through which idler shaft 23 passes. It is apparent, therefore, that interference disc 24 rotates with second driven gear 22 by virtue of the connection at pivot pin 37 and may oscillate with respect to this gear by virtue of arcuate slot 38.

A groove 40 is formed eccentrically in one side of the first driven gear 21 and serves as a means for oscillating interference disc 24. Displaced approximately 90° from pivot pin 37 and fixed to the disc 24 is a second pin 41, which projects from this disc into the groove 40 and therefore serves as a cam follower. In view of the circumferential displacement of pins 37 and 41, it will be seen that interference disc 24 will be oscillated about pivot pin 37 by an amount equal to the magnitude of eccentricity of groove 40 during each complete rotation of first driven gear 21 relative to second driven gear 22, which relative rotation is produced by first and second drive gears 15, 16, as explained hereinabove. The driven gears 21, 22 are angularly displaced relatively to one another, during rotation, an amount which corresponds to and is dependent upon the difference in the number of teeth chosen for drive gears 15, 16. Thus, it is seen that the follower pin 41 alternately is disposed adjacent to and remote from the axis of rotation of the driven gears, resulting in a rocking movement of the interference disc in addition to the rotation thereof.

A radial opening or slot 42 is formed in interference disc 24 and is displaced from the follower pin 41 by approximately 90°. This slot slidably receives a pin 43 rigidly mounted to control disc 25 and extending therefrom parallel to the axis thereof. A suitable arcuate opening 44 is formed in second driven gear 22 to permit operation of pin 43 and in order that the same may connect interference disc 24 with control disc 25. Any oscillation and rotation of interference disc 24 therefore is transmitted to the control disc 25 through the connecting pin 43. The particular mounting described immediately above permits rotation of control disc 25 at the same means speed as that of second driven gear 22 but also permits alternate leading and lagging of this disc with respect to the second driven gear. In view of the rigid connection between control disc 25 and contact disc 26, the latter follows the same movements as the former, from which impulses having an equal mean frequency but occurring in irregular succession may be obtained.

The contact discs 26, 30, 32 and 34 are provided with electrical contacts 45, 46, 47 and 48, respectively as shown in Figure 3. These contacts 45, 46, 47 and 48 cooperate with corresponding pickup devices 27, 31, 33 and 35, respectively, in order to supply control impulses to the aforesaid collecting line 36, which is common to all of the contact driving units and which feeds these impulses into common amplifying system 28. Each impulse may be derived electrically by direct supply of a current from the contacts to brushes, for example, or magnetically by remote action on an opposed magnet which controls a relay or similar element. If found to be necessary or desirable, however, the circuit may be closed mechanically by direct manipulation of a rocking lever or switch or by a displaceable piston which could convey the impulse hydraulically or pneumatically, in which cases the various contacts 45, 46, 47 and 48 could be replaced by cam lobes.

In the embodiment discussed herein, the four second drive gears 16 have been provided with an equal number of teeth. It is apparent, therefore, that the contact discs 26, 30, 32 and 34 rotate freely with respect to idler shaft 23 at the same mean speed. Upon inspection of Figure 3, it can be seen that the contacts of the respective discs are displaced on an average of 90° one from the other, which is to say that when the contact discs are rotated in the direction of the arrow and the contact 45 of disc 26 is approaching pickup device 27, the contact 48 of disc 34 has already passed corresponding pickup device 35. The contact 46 of the disc 30 runs on the average about 90° behind that of the first disc 26 and the contact 47 of the disc 32 an average of about 180° behind the first disc. By way of illustration, the zero positions of the discs 30, 32 and 34 are shown in chain-dotted lines on the contact disc 26 in Figure 3. If each contact is permitted to oscillate backwards and forwards, by means of its interference disc, within a certain interference range, which should in practice be a constant interference angle such as, for example, the interference angle 50 of the disc 26 or the similar angle 51 of the disc 30, an interference free range or angle 52 is formed between the interference angles 50 and 51 of the leading and following discs 26, 30, respectively. In this interference free range 52, which is shown by way of broken lines on disc 26, no electrical contact will ever be made. It is therefore possible, by replacement or suitable choice of the number of teeth on the gears 15, 16, 21 and 22 and also the other constructional data of the interference drive of the individual contact driving units 11, 12, 13 and 14, to establish a time interval in which no control impulses are given. This corresponds to the minimum spacing between the successive slubs. The necessary variation of the interference frequency is produced by proper selection of the number of teeth in drive gear 15 and driven gear 21 of each driving unit, the contact disc 26, for example, adjusting its oscillation period according to a basic rotational speed or interference frequency different from that of discs 30, 32 and 34.

Summary

In order to illustrate further the principle involved in the present invention, a specific example of a four unit impulse generator system will be discussed in connection with the diagram of Figure 4. Time is represented as the abscissa in the direction of arrow **53** and the angular position of the individual contact discs or their contacts is represented as the ordinate in the direction of arrow **54**. The spacing **55** between the individual adjacent straight lines **56**, **57**, **58** and **60** therefore represents the basic phase displacement or the size of the angle between the individual contacts **45**, **46**, **47** and **48**, which is shown to be approximately 90° with a system utilizing four contact driving units. It is possible, however, to alter the phase displacement, which would result in a change in the interference free angle **52** between successive contacts.

Plotted along respective lines **56**, **57**, **58** and **60** are sinusoidal curves or undulatory lines **61**, **62**, **63** and **64**, all of which have the same amplitude in the direction of arrow **54** but which have varying periods in the direction of arrow **53**. These undulatory lines represent those interference angles of different interference frequency which are to be superimposed on the fundamental phase or mean rotational speed. The curves **61**, **62**, **63** and **64** are generated by contact discs **26**, **30**, **32** and **34**, respectively, and, further, could assume a path other than sinusoidal if the shape of eccentric groove **40** in second driven gear **22** were appropriately designed.

The interference frequency is determined by the relative speed of the two driven gears **21**, **22**, as explained above. If the oscillatory deflection of the interference disc **24** is increased in one of the contact driving units **11–14**, the interference amplitude of the contact disc concerned will be increased accordingly. The interference angle range is indicated at **50** or **51** in Figure 3 or by the amplitude of the undulatory line **61** or **62** in Figure 4. Any such change will of course result in a corresponding alteration in interference free angle **52** shown in Figures 3 and 4. The inclined broken lines **65**, **66**, **67**, **68** and **70** shown in Figure 4 characterize in series the course of the fundamental rotation, the distance **71** between adjacent inclined lines always showing the time value for a full mean rotation of the contact discs. The full mean rotation **71**, therefore, is chosen here to be of a shorter time than the shortest interference period, here represented by period **72** of undulatory line **63**, the interference periods of curves **61**, **62** and **64** being represented by reference numerals **73**, **74** and **75**, respectively. It is, of course, also possible to produce other conditions by proper choice of relative speed ratios between the two driven gears **21**, **22**.

The various points **76**, **77**, **78**, **80**, **81**, **82** and **83** of intersection between the inclined lines **65**, **66**, **67**, **68** and **70** and the undulatory lines **61**, **62**, **63** and **64** represent the insertion points of the succeeding contact impulses, namely, in the required irregular manner as a function of time when measured in the direction of arrow **53** and as an angular function when measured in the direction of arrow **54**, as will appear by comparison of the spacing of the points of intersection on the inclined lines. It will also appear, however, that it is advisable to arrange for a contact disc with an interference frequency line of short period to be followed by one having a longer period in order to achieve a more rapid change of the impulse intervals, as shown in Figure 4.

The interference rotational speeds or oscillations superimposed on the fundamental or mean speed of rotation cause a constant alteration of the total rotational speed of each individual contact disc. For example, if the contact is made electrically by means of a sliding segment and a brush, a longer or shorter contact between the segment and brush will occur, depending on the momentary rotational speed of the contact disc. In the diagram of Figure 4, this operation is discerned from the

constantly changing actual inclination of the undulatory lines or curves **61**, **62**, **63** and **64**. If the point of intersection between an inclined line and a curve is in the ascending portion, for example the points **76**, **77**, **78** and **80**, the momentary rotational speed of the contact disc is barely reached and the contact-making time is therefore comparatively long. If the point of intersection is in the descending portion, however, for example at point **83**, the momentary rotational speed is increased, whereby the time during which contact is made is substantially shortened. This alteration in the time during which contact is made can be used for controlling within certain limits the impulse length and thus the length of the slubs to be produced. The contact-making time is changed to a proportionately greater extent when the period lengths **73**, **74**, **72** and **75** for curves **61**, **62**, **63** and **64**, respectively, are chosen to be shorter without changing the interference amplitude.

The minimum interval and the maximum interval of the impulses succeeding one another in the range of the angle of rotation can be established by the choice of the size of the interference angle with a given phase displacement angle of the fundamental contact position. Taking two juxtaposed contact discs, if the first rotates with the maximum momentary follow-up interference angle and the succeeding one with the greatest momentary initial interference angle, a contact sequence of shortest interval is obtained. Conversely, the largest interval is produced when the first interference disc rotates with the maximum lead and the second interference disc with the maximum follow-up. The number of contact discs is of decisive importance for a sufficiently high periodicity. Moreover, with a given number of discs, it is also necessary that the interference frequencies should not have a common divisor. In order for the irregularities of the slub sequence in the subsequently finished textile material to be more clearly apparent, it is advisable that the differences in interference frequency of the separate contact discs following one another be chosen as large as possible. The interference discs could, for example, be designed as toothed gears. Furthermore, the groove **40** in first driven gear **21** could be replaced with any desired cam means designed for performing the same function.

The above described impulse generator system is disclosed for purposes of illustration only and is not intended to limit the present invention. It is possible, for example, to utilize interference discs functioning in a different manner and for the impulses to be transmitted by any desired intermediate carrier. Instead of supplying impulses from amplifier system **28** to a means for actuating a supplementary spinning pump, it is of course possible to utilize the present system for directly charging or magnetizing a tape which, subsequently, could be used for actuating a supplementary spinning pump. Depending on the period after which the same sequence **76**, **77**, **78**, etc., is repeated, it is possible to provide more or less than four contact discs. The only essential feature is that the separate interference frequencies, as generators of the contact-making operation taking place at different times, not have a common divisor.

Various other modifications and changes are contemplated and obviously may be resorted to without departing from the spirit and scope of the invention as hereinafter defined by the appended claims.

What is claimed is:

1. A contact driving unit comprising a drive shaft, a pair of drive gears rigidly mounted on said drive shaft, means for rotating said drive shaft, an idler shaft, a pair of driven gears relatively rotatably supported by said idler shaft and meshing with respective ones of said drive gears, an interference disc and means mounting said interference disc for rotation with and for oscillation with respect to one of said driven gears.

2. A contact driving unit comprising a drive shaft, a

pair of drive gears rigidly mounted on said drive shaft, means for rotating said drive shaft, an idler shaft, a pair of driven gears relatively rotatably supported by said idler shaft, said driven gears meshing with respective ones of said drive gears, an interference disc pivotally mounted to one of said driven gears for rotation therewith and means responsive to rotation of the other of said driven gears for oscillating said interference disc during the rotation thereof.

3. A contact driving unit comprising a drive shaft and an idler shaft, means for rotating said drive shaft, first and second drive gears rigidly mounted on said drive shaft, said drive gears having an unequal number of teeth, first and second driven gears supported for relative rotation by said idler shaft and meshing with said first and second drive gears, respectively, an interference disc disposed intermediate said first and second driven gears, means pivotally mounting said interference disc for rotation with said second driven gear and means operative in response to relative rotation between said first and second driven gears for oscillating said interference disc during rotation thereof.

4. A contact driving unit comprising a drive shaft and an idler shaft, means for rotating said drive shaft, first and second drive gears rigidly mounted in spaced relationship on said drive shaft, said drive gears having an unequal number of teeth, first and second driven gears freely and relatively rotatably supported by said idler shaft and meshing with said first and second drive gears, respectively, an interference disc pivotally supported by said second driven gear and rotatable therewith, and cam means on said first driven gear for oscillating said interference disc during the rotation thereof.

5. A contact driving unit comprising a drive shaft and an idler shaft, a pair of drive gears rigidly mounted on said drive shaft, a pair of driven gears rotatably supported by said idler shaft and meshing with respective ones of said drive gears, an interference disc, means mounting said interference disc for rotation with and for oscillation with respect to one of said driven gears and means operative in response to movement of said interference disc for triggering a control impulse.

6. A contact driving unit comprising a drive shaft and an idler shaft, first and second drive gears rigidly mounted on said drive shaft, said gears having an unequal number of teeth, first and second driven gears supported for relative rotation on said idler shaft and meshing with said first and second drive gears, respectively, an interference disc pivotally mounted on said second driven gear for rotation therewith, means defining an eccentric groove in one side of said first driven gear for oscillating said interference disc in response to relative rotation between said first and second driven gears, a control disc for triggering an electrical impulse and means connecting said control disc for rotation and oscillation with said interference disc.

7. An impulse control system comprising a drive shaft, means for rotating said drive shaft, a plurality of groups of drive gears rigidly mounted on said drive shaft, each group consisting of a first and second drive gear, said first drive gears having a different number of teeth not only with respect one to the other but also with respect to said second drive gears, an idler shaft, a plurality of groups of driven gears relatively rotatably supported by said idler shaft, each group consisting of a first and second driven gear, each of said first and second driven gears meshing with corresponding first and second drive gears, respectively, an interference disc for each second driven gear and means mounting said interference discs for rotation with and for oscillation with respect to corresponding second driven gears.

8. An impulse control system comprising a drive shaft, means for rotating said drive shaft, a plurality of groups of drive gears rigidly mounted on said drive shaft, each group consisting of a first and second drive gear, said first drive gears having a different number of teeth not only with respect one to the other but also with respect to said second drive gears, an idler shaft, a plurality of groups of driven gears supported for relative rotation by said idler shaft, each group consisting of a first and second driven gear, each of said first and second driven gears meshing with corresponding first and second drive gears, respectively, a plurality of interference discs, means pivotally mounting an interference disc for rotation with each of said second driven gears and means for oscillating each of said interference discs in response to relative rotation between the first and second driven gears of each group.

9. An impulse control system comprising a drive shaft, a plurality of groups of drive gears rigidly mounted on said drive shaft, each group consisting of a first and second drive gear, said first drive gears having a different number of teeth not only with respect one to the other but also with respect to said second drive gears, an idler shaft, a plurality of groups of driven gears supported for relative rotation by said idler shaft, each group consisting of a first and second driven gear, each of said first and second driven gears meshing with corresponding first and second drive gears, respectively, and means operative in response to relative rotation between the first and second driven gears of each group for generating impulses of equal mean frequency but which occur in irregular succession.

10. An impulse control system comprising a drive shaft, a plurality of groups of drive gears rigidly mounted on said drive shaft, each group consisting of a first and second drive gear, said first drive gears having a different number of teeth not only with respect one to the other but also with respect to said second drive gears, an idler shaft, a plurality of groups of driven gears supported for relative rotation by said idler shaft, each group consisting of a first and a second driven gear, each of said first and second driven gears meshing with corresponding first and second drive gears, respectively, an interference disc pivotally mounted for rotation with each of said second driven gears, means operative in response to relative rotation between said first and second driven gears for oscillating said interference disc during rotation thereof and means operatively connected to each of said interference discs for generating an impulse in response to movement of said interference disc, said impulses occurring at irregular intervals but having an equal mean frequency over a prolonged period of operation.

11. Apparatus for generating control impulses of equal mean frequency which follow one another in irregular succession comprising a plurality of relatively rotatable contact discs, means for triggering an electrical impulse in response to the rotation of each of said contact discs and means for rotating said contact discs at an equal mean frequency and for oscillating said discs one relative to the other at irregular interference frequencies.

12. Apparatus for generating control impulses of equal mean frequency which follow one another in irregular succession comprising a plurality of relatively rotatable contact discs having means for triggering an electrical impulse in response to the rotation thereof, drive means for rotating said discs at an equal mean frequency and means driven by said drive means for oscillating said discs one relative to the other during rotation.

13. Apparatus for generating control impulses comprising a plurality of relatively rotatable contact discs, means on each of said contact discs for triggering an electrical impulse in response to the rotation thereof, drive means for rotating said contact discs at an equal mean speed whereby a predetermined number of impulses will be emitted over a given period of time, interference means for oscillating said contact discs one relative to the other during rotation whereby said impulses will be distributed in irregular succession and means common to said contact discs for collecting said impulses.

14. Impulse generating apparatus for controlling spinning machines in the manufacture of artificial yarn having a fluctuating denier comprising a plurality of relatively rotatable contact discs having means thereon for triggering an electrical impulse in response to rotation thereof, said contact discs being displaced in phase relative one to the other, drive means for rotating said contact discs at an equal mean speed whereby a predetermined number of impulses will be emitted over a given period of time, interference means for oscillating said contact discs one relative to the other whereby said impulses will be distributed in irregular succession and means common to said contact discs for collecting and amplifying said impulses.

15. Impulse generating apparatus for controlling spinning pumps in the manufacture of slub rayon comprising a plurality of relatively rotatable contact discs, means on each of said contact discs for triggering an electrical impulse in response to the rotation thereof, said triggering means being displaced in phase one relative to the other, adjustable drive means for rotating said contact discs at an equal mean speed whereby a predetermined number of impulses will be emitted over a given period of time, adjustable interference means superimposed upon said drive means for oscillating said contact discs one relative to the other whereby said impulses will be distributed in irregular succession and means for collecting and conducting said impulses into a common amplifier system.

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