June 30, 1925. 1,543,813

G. F. ATWOOD

IMPULSE GENERATING DEVICE

Filed July 14, 1923

Fig. 1.

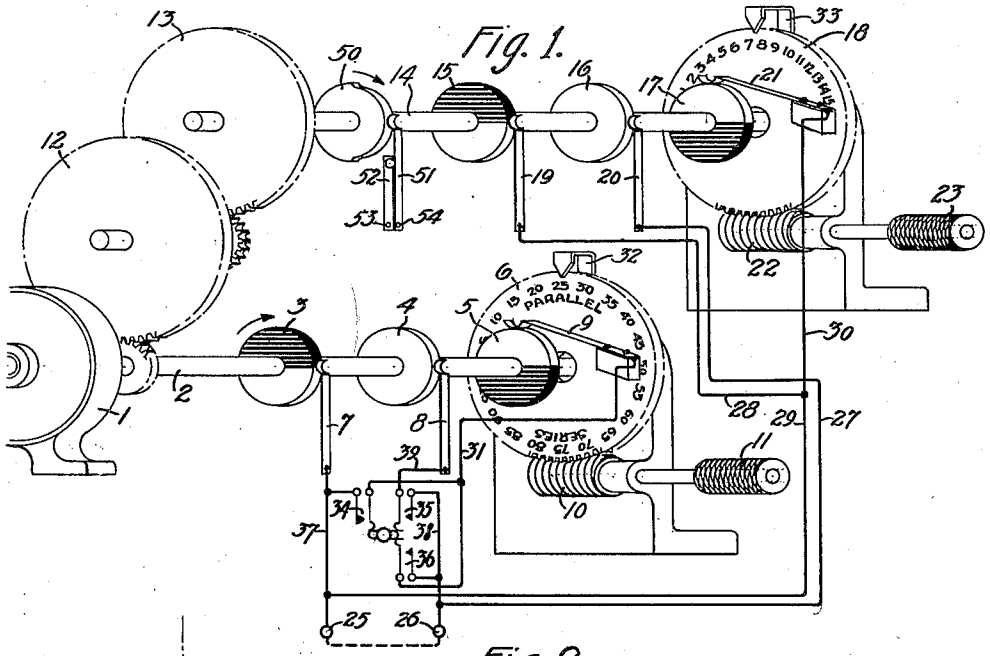


Fig. 2.

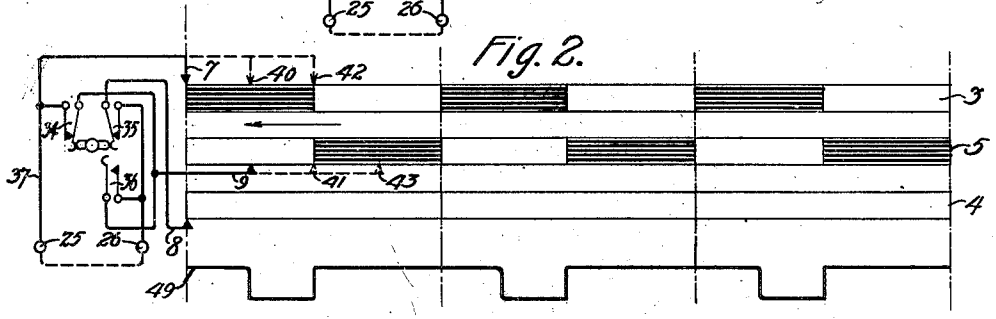
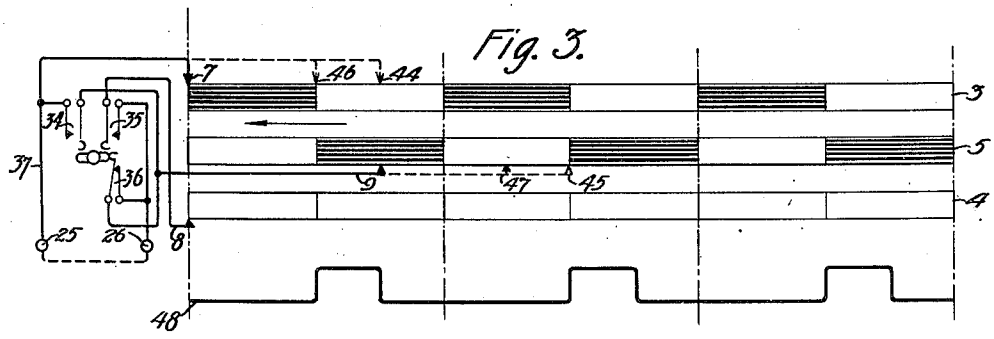


Fig. 3.



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UNITED STATES PATENT OFFICE.

GEORGE F. ATWOOD, OF NEWARK, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

IMPULSE-GENERATING DEVICE.

Application filed July 14, 1923. Serial No. 651,488.

To all whom it may concern:

Be it known that I, GEORGE F. ATWOOD, a citizen of the United States of America, residing at Newark, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Impulse-Generating Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to electrical impulse sending mechanisms and particularly to the transmission of uniformly spaced impulses of predetermined characteristics.

The object of the invention is the provision of a mechanism whereby impulses having characteristics similar to those transmitted by a telephone calling dial, as used in automatic telephony, may be generated.

A feature of the invention is the provision of means for varying the relative duration of the break period and the make period comprising any one impulse.

Another feature is to provide means to transmit series of impulses consisting of any desired number of impulses and to repeat such series indefinitely.

A further feature of the invention is that adjustments to vary the number of impulses per series and the characteristics of the individual impulses may be made while the device is in operation.

In testing the operation of automatic telephone selecting equipment, such as relays and selector switches, in response to impulses from a calling dial, it has heretofore been common practice for an attendant to operate an ordinary service calling dial a description of which may be found in Patent No. 1,161,854, November 30, 1915 to O. F. Forsberg. The impulses thus sent are always under the attendant's control. This method of course, is unsatisfactory for several reasons. In the first place, the expense of having an attendant perform this work is great. The impossibility of employing an attendant for life tests of apparatus involved is apparent, since the impulsing must be done continuously.

More important, however, is the fact that the results obtained are not completely satisfactory. The impulses transmitted by a telephone calling dial consist of two distinct periods, one in which the circuit is closed, or the make period, and the other in which the circuit is opened, or the break period. The relative duration of these periods varies considerably as between individual dials and sometimes in the same dial the periods in succeeding impulses show considerable variation. It is often necessary to know the behavior of the apparatus in response to dial impulses of extreme characteristics and to know definitely and accurately beforehand what characteristics the impulses possess. It is therefore necessary that some means be provided to replace the unsatisfactory method of manual dialing and to eliminate resulting inaccuracies.

In the particular embodiment herein set forth, the percentage break may be varied continuously from zero to 100 by the manipulation of a knurled handle and the particular value is indicated plainly to the operator. In a similar way the number of impulses in a train of impulses may be varied from one up to and including 29.

These and other features of the invention will be better understood by a reference to the accompanying drawings. Fig. 1 shows a schematic arrangement of a preferred form of the machine. Figs. 2 and 3 are diagrams showing the relation of make period to break period under various conditions as will be more fully described hereinafter in connection with Fig. 1.

In Fig. 1, motor 1 drives shaft 2 either directly or by means of suitable gears. Shaft 2 carries thereon three metal interrupter drums 3, 4 and 5 of uniform size. Drums 3 and 5 are each constructed of two equal segments, one of insulating material and the other of conducting material. When mounted on shaft 2 their insulated segments are always on opposite sides of the shaft. In the drawing the shaded portion represents insulation and the clear portion represents conductor. Drum 4 is of solid metal. Electrical connection is maintained from drums 3, 4 and 5 by means of metallic shaft 2. Fixed brushes 7 and 8 are caused to wipe over drums 3 and 4 respectively while drum 5 is engaged by movable brush 9 which is mounted on a revoluble disc 6. This disc 6 is mounted concentrically with but independent of shaft 2 and is controlled by a knurled handle 11 by means of worm 10 in engagement with teeth cut in the circumference of the disc. Disc 6 in turn controls the relative position of brush 9 with respect to its associated drum 5. Disc 6 is calibrated

to read percentage break in connection with indicator 32 but it may also be calibrated to read in any other convenient unit which is a function of percentage break. Driven by shaft 2 through suitable reducing gears 12 and 13 is shaft 14 having mounted thereon a series of cams or drums similar to those mounted on shaft 2. Drums 15, 16 and 17 are similar to drums 3, 4 and 5, respectively. Brushes 19, 20 and 21 are similar to brushes 7, 8 and 9 respectively. Disc 18 is similar to disc 6 but it is calibrated to read the number of pulses to be sent in one train or series or its equivalent. The setting of this disc is controlled by handle 23 in a similar manner to disc 6.

A double throw key 24 is so connected that, when operated upward, drums 3 and 5 are connected in parallel through drum 4 to terminals 25 and 26, and when operated downward, a circuit is completed in series through commutators 3, 4 and 5.

When key 24 is operated to connect the drums in parallel, contacts 34 and 35 are closed and a circuit may be traced from terminal 25, conductor 37, brush 7, drum 3, shaft 2, drum 4, brush 8, conductor 39, contact 35, conductor 38, to terminal 26. At the same time a parallel circuit may be traced from terminal 25, conductor 37, contact 34, conductor 31, brush 9, drum 5, shaft 2, drum 4, brush 8, contact 35, conductor 38 to terminal 26. It is thus seen that drums 3 and 5 are connected in parallel. This relation is better shown in Fig. 2 where the drums have been developed into plane surfaces, the brushes being indicated by arrows. Corresponding parts bear the same reference characters. The relative positions of the brushes as shown in Fig. 1 are for a condition of 25% break as indicated by pointer 32. Brush 9 is shown 90° in advance of brush 7. Considering the rotation of the drums as indicated by the arrows in Fig. 2 it is seen that as the drums move relatively to the brushes 7 and 9 there will be a closed circuit through one of the parallel paths above traced (that is, the one through brush 9), from terminal 25 to terminal 26 until the brushes reach positions indicated by the dotted arrows 40 and 41. From that point until the brushes are in the positions indicated at 42 and 43 they are both passing over insulation. This condition lasts for 25% of a revolution. After reaching position 42, brush 7 engages the metal segment of drum 3 and the circuit is again closed. By adjusting brush 9 to any position with relation to brush 7, it is easily apparent that the percentage break may be varied from zero, when brushes 9 and 7 are in alignment to 50 when brush 9 is 180° in advance of brush 7. Curve 49 in Fig. 2 shows the duration of the condition of make and break; the lower loop representing break periods and the upper loops make periods. Of course, by the use of the parallel connection it is seen that only percentages break from zero to 50 will be obtained. In order to cover the range from 50 to 100, the key 24 is operated to the series position. Contacts 34 and 35 are opened and contact 36 is closed and a circuit may be traced from terminal 25, conductor 37, brush 7, drum 3, shaft 2, drum 5, brush 9, conductor 31, contact 36, back to terminal 26. The two drums are thus placed in series. This condition is more easily seen by a reference to Fig. 3 where the key 24 is shown thrown to the series position and the drums are developed into flat surfaces. The relative direction of rotation of the drums is indicated by the arrow. With the drums in series, with either brush 7 or brush 9 or both engaging an insulating segment, the circuit is broken and a break period occurs. In the case illustrated in Fig. 3, with brushes 7 and 9 in the position shown, the circuit is broken. As they move relatively with respect to the drums the circuit remains broken until they reach positions 46 and 47 respectively. In those positions both brushes are resting on conducting segments and the circuit is closed through in series. This condition continues until the brushes reach positions 44 and 45 when brush 9 engages the insulation segment of drum 5. The conditions of make and break can thus be traced and a curve as shown at 48 described. The lower loops indicate break periods and the upper loops make periods. By adjusting the angular lead of brush 9 over brush 7 from 180° to 360° break periods ranging from 50 to 100% may be obtained. This can be done while the machine is rotating simply by manipulating handle 11. Below is shown a table representing the percentage break corresponding to an advance in degrees of the brush over the stationary brush.

Advance in degrees of movable brush with respect to stationary brush	Percentage break
BRUSHES IN PARALLEL	
0	0
45	12½
90	25
135	37½
180	50
BRUSHES IN SERIES	
180	50
225	62½
270	75
315	87½
349	97 practical limit.
360	100

It has thus been shown how a continuous train of pulses of varying percentage make and break may be transmitted. However,

when testing selector switches, for which this machine was primarily designed, it is necessary to transmit a train consisting of a definite number of pulses, then allowing a closed period of definite duration to elapse, and to repeat this process indefinitely. This is accomplished by connecting in parallel with the above described machine a second mechanism driven at a slower rate of speed by the same motor through suitable reduction gears.

In the particular embodiment described a speed reduction ratio of 30 to 1 is employed. Shaft 14 thus makes one revolution while shaft 2 is making 30. The apparatus carried on shaft 14 is similar in all respects to that carried on shaft 2 except that the time for one complete pulse is longer. Also, instead of reading percentage breaks from drum 18 the calibration is in pulses per train. The operation of the apparatus on shaft 14 in relation to that on shaft 2 is as follows: While motor 1 is in continuous operation it drives shaft 2, thus causing a continuous train of pulses to be sent out at terminals 25 and 26, consisting of the make period and the break period as indicated by pointer 32. It is necessary, of course, since a calling dial is short-circuited between series of pulses, that, in order to simulate its action, means be provided for such short-circuiting. When making tests for an indefinite period, such as life tests, on register apparatus used in automatic telephone systems this operation is better performed automatically. This is done by making use of the apparatus on shaft 14. A parallel short-circuiting path then exists from terminal 26, conductor 27, brush 20, to drum 16, dividing at that point into two paths one through drum 15, brush 19 and conductor 28 and the other through drum 17, brush 21, and conductor 30 both terminating in conductor 29 and terminal 25.

Whenever either brush 19 or 21 or both are in engagement with a conducting segment of its drum there will be a short-circuit across terminals 25 and 26 and no pulses can be transmitted to the line. The duration of such short circuit depends upon the percentage make and break which is in turn dependent upon the relative positions of brushes 19 and 21. Therefore the graduations on disc 18 are in pulses per train which is a product of percentage break. By this method trains consisting of from one to 15 pulses may be sent. By connecting drums 15, 16 and 17 in series by means of a key identical to key 24, it is apparent that pulses of from 16 to 29 may be obtained in one train.

In order not to mutilate trains of pulses shafts 2 and 14 are so synchronized that brush 19 is making contact with the conducting portion of drum 15 at the same time that brush 7 makes contact with the conducting portion of drum 3. This may be accomplished by slipping gears 12 and 13 and turning shaft 14 until the proper position is obtained. This relative position will be maintained thereafter because of the definite ratio of speed reduction.

In practice, shaft 2 is timed to make one revolution per second and therefore sends out one pulse consisting of a make and a break period per second. This speed, however, may be varied at will by varying the speed of motor 1 by means of a rheostat connected in series with its armature. The speed may then be indicated on an electric tachometer properly connected in the motor circuit. The scale of the indicator may be calibrated to read directly in pulses per second, that being a function of speed. Shaft 14, however will always rotate 1/30th the speed of shaft 2. At the speed assumed of one revolution per second for shaft 2, drums 15, 16 and 17 turn one revolution in thirty seconds.

Shaft 14 carries a drum 15 arranged to close contacts 51 and 52 during one half revolution and to open them during the second half revolution. The terminals of any circuit to be interrupted are then connected directly to terminals 53 and 54, respectively and a make and a break period of equal duration are provided.

What is claimed is:

1. In a transmitting system, a circuit, means to transmit a plurality of series of current impulses thereover, means to transmit the impulses of each series at a measured ratio between the duration of a particular impulse and the time spacing between successive impulses, means to vary said ratio at will, and means to introduce a time spacing between said series of impulses.

2. In a transmitting system, a circuit, means to transmit a plurality of series of current impulses thereover, means to vary the number of impulses in a series at will, means to repeat any particular series any desired number of times, means to transmit the impulses of each series at a measured ratio between the duration of a particular impulse and the time spacing between successive impulses, and means to vary said ratio at will.

3. In a transmitting system, a circuit, an interrupter, means to operate said interrupter to produce interruptions in said circuit, a second interrupter, means to drive said interrupters simultaneously at different speeds, and circuit connections completed by said second interrupter to render ineffective said interruptions.

4. In a transmitting system, a circuit, an interrupter, means to operate said interrupter to produce interruptions in said circuit, a second interrupter, means to drive

said second interrupter at a different speed from said first interrupter but in fixed speed ratio thereto, and circuit connections completed by said second interrupter to render ineffective said interruptions.

5. In a transmitting system, a circuit, an interrupter, means to operate said interrupter to produce interruptions in said circuit, a second interrupter, means to drive said interrupters simultaneously at different speeds, and circuit connections completed by said second interrupter to render ineffective certain ones of said interruptions.

6. In a transmitting system, a circuit, an interrupter, means to operate said interrupter to produce a plurality of series of interruptions in said circuit, a second interrupter, means to drive said second interrupter simultaneously with said first interrupter, and circuit connections completed at said second interrupter to render ineffective certain ones of said first interruptions.

7. In a transmitting system, a circuit, an interrupter, means to operate said interrupter to produce a plurality of series of interruptions in said circuit, a second interrupter, means to drive said second interrupter simultaneously with said first interrupter, and circuit connections completed by said second interrupter to render ineffective certain ones of said first interruptions, and means to vary the number of impulses per series at will.

8. In a transmitting system, a circuit, a rotary interrupter, means to drive said interrupter to produce a plurality of series of interruptions in said circuit, a second rotary interrupter, means to drive said second interrupter simultaneously with said first interrupter, and circuit connections completed by said second interrupter to render ineffective certain ones of said first interruptions, and means to vary the angular relation of said interrupters.

9. In a transmitting system, a circuit, a rotary interrupter, means to drive said interrupter to produce a plurality of series of interruptions in said circuit, a second rotary interrupter, means to drive said second interrupter simultaneously with said first interrupter, and means to vary the angular relation of said interrupters, circuit connections completed by said second interrupter to render ineffective certain ones of said interruptions, there being a definite number of interruptions in each series, and means to vary the number of interruptions per series by varying the angular relation of said interrupters.

10. In a transmitting system, a circuit, means to transmit a plurality of series of current impulses thereover, means to transmit the impulses of each series at a measured ratio between the duration of a particular impulse and the time spacing between successive impulses, and means to vary said ratio at will during said transmission of impulses.

11. In a transmitting system, a circuit, means to transmit a plurality of series of current impulses thereover, means to vary the number of impulses in a series at will during said transmission, means to repeat any particular series any desired number of times, means to transmit the impulses of each series at a measured ratio between the duration of a particular impulse and the time spacing between successive impulses, and means to vary said ratio at will during said last mentioned transmission of impulses.

12. In a transmitting system, a circuit, means to transmit impulses thereover at a measured ratio between the duration of a particular impulse and the time spacing between successive impulses, means to vary said ratio at will, an indicating device, and means to indicate the value of said measured ratio on said indicating device.

13. In a transmitting system, a circuit, means to transmit a plurality of series of current impulses thereover, means to vary the number of impulses per series, an indicating device, and means to indicate on said indicating device the number of impulses per series.

14. In a transmitting system, a circuit, means to transmit a plurality of series of current impulses thereover, means to transmit the impulses of each series at a measured ratio between the duration of a particular impulse and the time spacing between successive impulses, indicating devices, and means to indicate on said indicating devices the number of impulses per series and the value of said measured ratio.

In witness whereof, I hereunto subscribe my name this 9th day of July A. D., 1923.

GEORGE F. ATWOOD.