United States Patent

Kratt

[15] **3,670,152**

[45] **June 13, 1972**

[54] RESET ERROR DETECTING PULSE COUNTER

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[73] Assignee: **J. Hengstler K.G.**, Aldingen, Germany

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[30] **Foreign Application Priority Data**

June 20, 1969 Germany ..... P 19 31 367.8

[52] **U.S. Cl.** ..... **235/144 HC**

[51] **Int. Cl.** **G06c 15/42**

[58] **Field of Search** ..... 235/144 HC, 144, 132, 132.1

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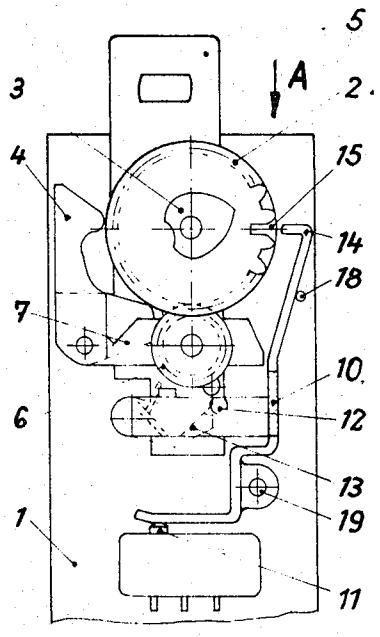
[57] **ABSTRACT**

The counter comprises a plurality of rotatable digit wheels. A pinion bridge carries pinions and tends to assume an operative position, in which said pinions are in mesh with respective ones of said digit wheels and operable to rotate the same. The pinion bridge is movable from said operative position to an inoperative position, in which said pinions are disengaged from said digit wheels. Resetting means are operable to move said pinion bridge to and hold it in said inoperative position and to rotate said digit wheels to a predetermined reset position. Feeler means are engageable with said digit wheels and said pinion bridge and operable to a reset-confirming position when, and only when, said digit wheels and said pinion bridge are in said predetermined reset position and said operative position, respectively. Indicating means are adapted to derive from the position of said feeler means an indication when said feeler means are operated to a position short of said reset-confirming position.

21 Claims, 10 Drawing Figures



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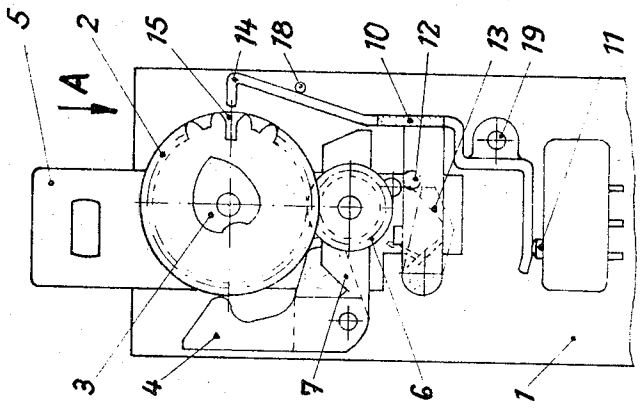

Fig. 2

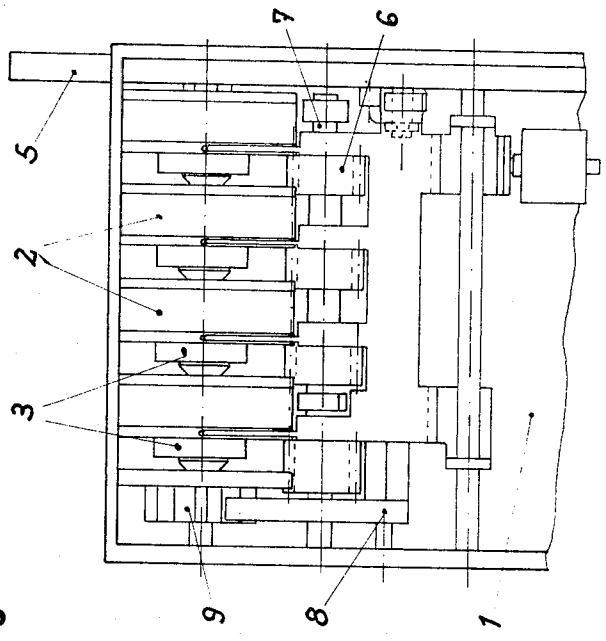

Fig. 1

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Fig. 3

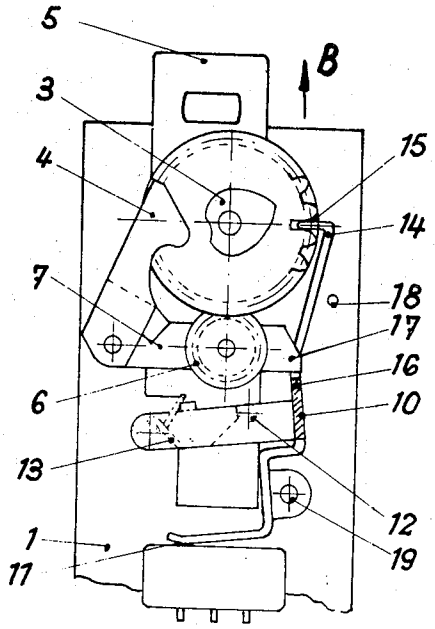
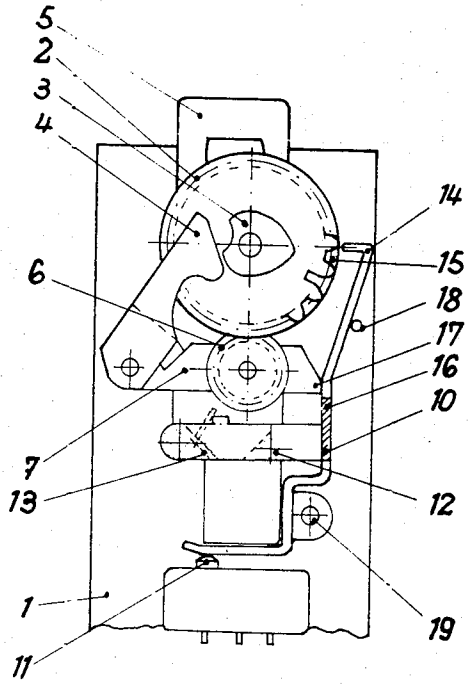


Fig. 4



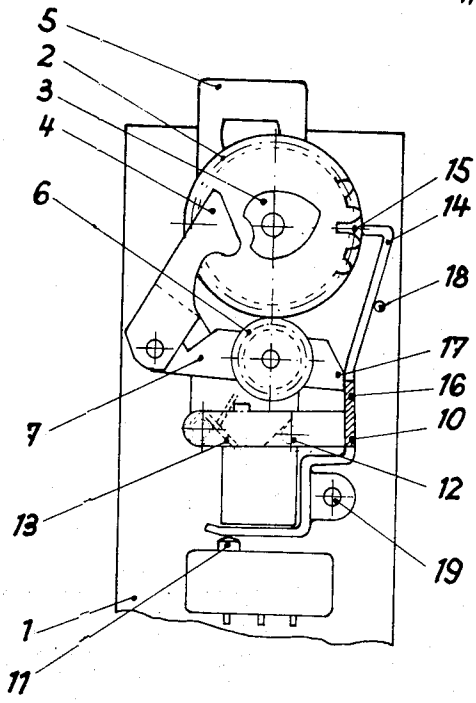


Fig. 5

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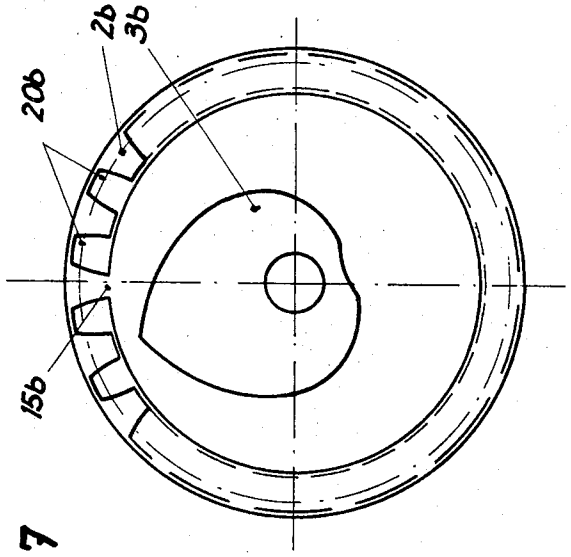

Fig. 7

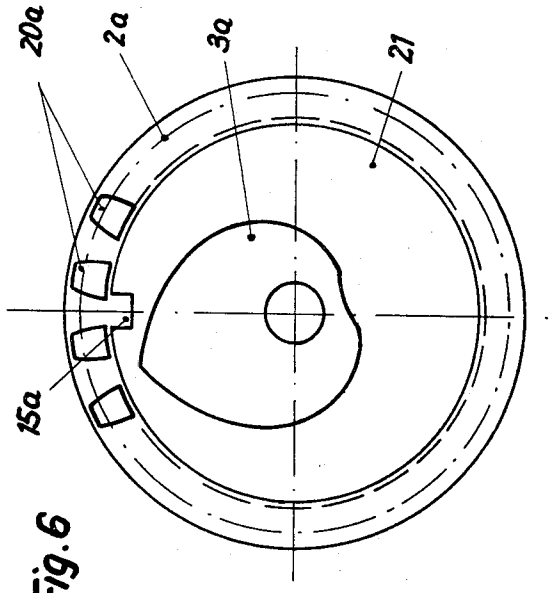

Fig. 6

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FIG. 8

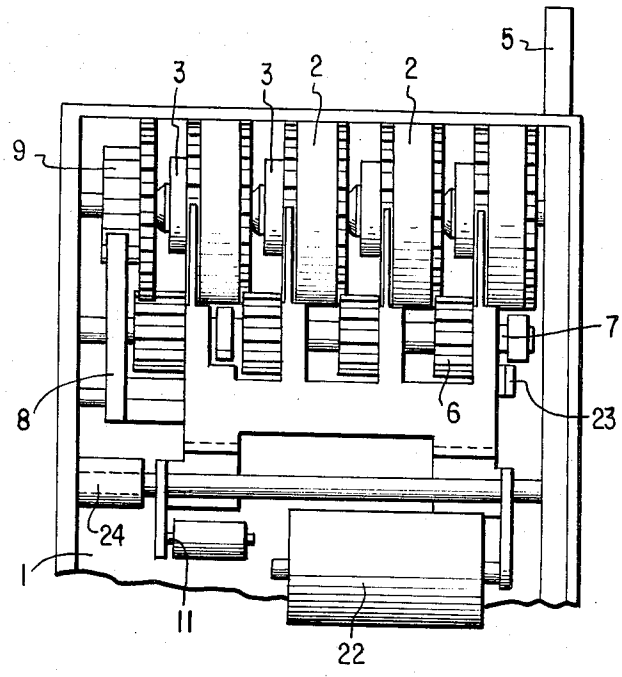
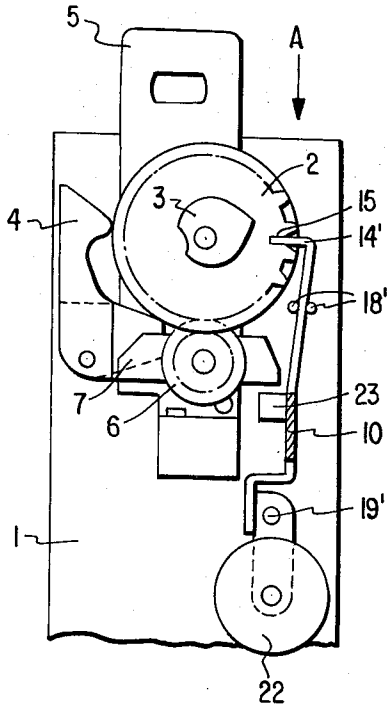


FIG. 9



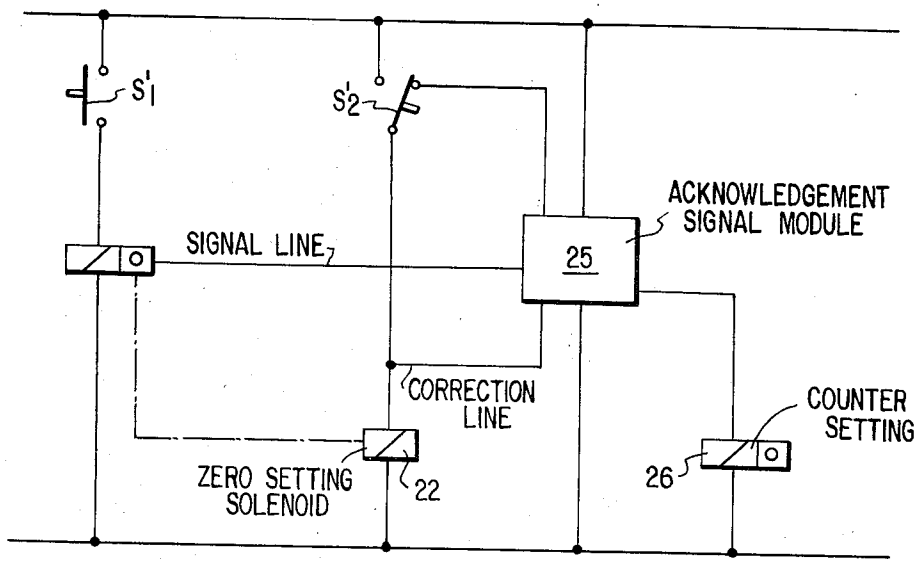


FIG. 10

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RESET ERROR DETECTING PULSE COUNTER

This invention relates to a device for detecting zero-setting or resetting errors in pulse counters.

In electromagnetically resettable pulse counters, which are used in automatic plants, an always correct operation is not ensured because the previously known resetting operations require a pivotal movement of the stepping drive means for a short time when the digit wheels have to be reset. It has not been possible before to obtain an absolute reliability by the use of known means, enforced sequences of operation and prolonged resetting times. The previously known solutions for increasing the accuracy of the zero-setting operation, particularly in counters in which the resetting or zero-setting device is automatically operated electromagnetically, have resulted in a higher safety but have not ensured a reliable function. Experience shows that the use of parts which are subjected to wear reduces the reliability of operation as the time of use proceeds and renders the use of such counters in important control systems questionable long before the usual life has expired.

It has also been attempted to increase the functional reliability by the use of two parallel counters. This concept, however, involves higher costs and a larger space requirement. Besides, all known solutions have the disadvantage that a defect is not immediately indicated but may result in considerable disturbances in or damage to the plant which is controlled with the aid of the counter.

According to the invention, these disadvantages are avoided in that a feeler is provided, which serves to check the correct performance of the resetting operation and during the return movement of the resetting device senses the position of the digit wheels and the position of the pinion bridge. This feeler consisting of an integral rake has associated therewith a signalling contact means in such a manner that a signal is generated only when all rake elements associated with the digit wheels are received by the latter after a correct resetting operation and the pinion bridge is in its correct position so as to permit the feeler to perform its entire feeler stroke. The feeler is preferably operated during the return movement of the resetting key and by means of a cam which is secured to the latter and which cooperates with a resilient pawl, which is mounted on a feeler lever that is disposed before the signalling means. In this arrangement, the feeler is operated during the return stroke of the resetting key so that the latter reaches its end position and the feeler is swung back to its initial position when the wheels and pinion bridges are in correct position.

If the feeler performs its entire stoke, the switch which is associated with the feeler is operated to generate a signal. If one or more wheels or the pinion bridge are in a wrong position, the feeler will perform a smaller stroke so that an operation of the switch will be prevented and the means operatively connecting the resilient pawl and the key prevent the latter from reaching its end position. As a result of this limitation of the return movement of the resetting key, the manual, mechanical resetting operation will result in a visual indication of the correct performance of the resetting operation. In contrast to an electromechanical operation, the switch and the electric circuit required for an automatic signal utilization may be omitted.

To enable a sensing of the digit wheels in the zero position or reset position, the digit wheels must be provided with grooves, which are arranged to receive the feeler when the wheels are in the desired end position. It is known to provide digit wheels in a separate rim portion with grooves for receiving a feeler. This design has the disadvantage that the width of the digit wheel is increased. In other embodiments, this feeler-receiving groove is formed in the digit-bearing cylindrical surface of the digit wheel so that the digits are partly mutilated.

To avoid this disadvantage, the invention teaches to sense the wheel at the spur gear teeth which are required in any case. To this end, that tooth space which in the zero position of the wheel is in register with the feeler is deeper or open-bottomed. In adjustable counters, all tooth spaces are open-bottomed to receive the cam-carrying detent member so that a groove formed in the detent member becomes accessible for the feeler. Because the angular position of that feeler-receiving groove in the reset position of the cam matches the sensing position of the feeler, the feeler will detect the correct reset position, whereas the sensing movement of the feeler will be obstructed if one or more digit wheels are in a wrong position, regardless of the number to which they have been set.

In counters provided with automatic electromagnetic resetting means, the signal may be utilized by a relay circuit comprising a polarized relay, which in response to a zero-setting pulse assumes a predetermined position and is reset by the signal pulse which is generated in response to a correct resetting operation. This relay operation results in a short pulse in response to a correct resetting operation and in a continuous signal in response to a wrong resetting operation. In another embodiment, this signal may be used to initiate another resetting operation (correcting resetting operation).

In the drawing:

FIGS. **1** to **5** show a device according to the invention for detecting errors in zero-setting or resetting operations in pulse counters in different positions.

FIGS. **6** and **7** show further details.

FIGS. **8** and **9** are views similar to FIGS. **1** and **2** showing an alternative embodiment of a device according to the present invention.

FIG. **10** is a schematic diagram of means arranged to operate resetting means in response to a signal.

As is apparent from the drawing, the pulse counter **1** comprises in known manner digit wheels **2** provided with cardioid cams **3**, also resetting levers **4** and a resetting or zero-setting key **5**. The stepping pinions **6** are carried by the pinion bridge **7** and for a resetting or zero-setting operation are disengageable from the digit wheels **2**. As is also known, the counter is stepped by electromagnetic means **8**, **9** under control by a pulse generator in known manner.

According to the invention, the counter comprises an additional feeler in the form of an integral feeler rake **10**, which is a bellcrank lever in the embodiment of FIGS. **1** through **5**, for all digit wheels **2** and the pinion bridge **7**, also an indicating or signalling means in the form of a pressure contact **11**. An operation of the resetting key **5** according to FIG. **2** in the direction A causes the cam or pin **12** to impart a pivotal movement to the spring-loaded pawl **13** mounted on the rake **10** whereas the latter is not operated. When the resetting key **5** is returned by spring action in the direction B in FIG. **3** after the digit wheels **2** have been reset or set to zero after the pinion bridge **7** had been operated to disengage the pinions **6** from the digit wheels **2**, the pin **12** will carry along the stop-coupled pawl **13** and the rake **10**. If the digit wheels **2** have been properly reset, each feeler finger **14** will extend into the groove **15** in the digit-carrying surface of the associated wheel **2**. If the pinions **6** and the pinion bridge **7** have been properly swung into the correct engaging position, the sensing edge **16** can move pivotally past the cam **17**, as is also apparent from FIG. **3**. This operation will result in an operation or release of the pressure contact **11**. When the pin **12** has been moved past pawl **13** and the key **5** has returned, the rake **10** will perform a return pivotal movement to its initial position under the action of the pressure contact **11** or of a special spring until the rake **10** engages the stop **18**.

If one or more digit wheels **2** are not properly reset, e.g., because they have overrun the desired position, the position shown in FIG. **4** will be obtained, in which the rake **10** provided with feeler fingers **14** cannot swing into the grooves **15** because at least one of the latter is not in the correct position. In this case, the resetting key cannot return to its initial position because its pin **12** is blocked so that a wrong resetting operation is visually indicated. On the other hand, the contact **11** is not operated and an electric signal will not be generated unless the resetting operation has been properly performed.

If the pinions **6** and the pinion bridge **7** cannot swing home entirely, e.g., because the teeth are in improper positions, the situation shown in FIG. **5** will result. In this case, the sensing

edge 16 of the rake 10 cannot perform a pivotal movement past the cam 17 and the rake 10 will be in the same position as with improperly reset digit wheels 2. The results will also be the same.

In the embodiment shown by way of example, the feeler fingers 14 extend radially into the resetting grooves 15 formed on the digit wheels. Alternatively, the fingers 14 could axially extend into the grooves as is shown in the embodiment of FIGS. 8 and 9. The feeler rake is integral and pivoted at 19. If digit wheels 2 have not been properly set to zero or reset or the pinions 6 and the pinion bridge 7 have not been properly moved to a meshing position, the movement of the feeler rake 10 will be shorter so that the signalling means 11 will not be operated and another zero-setting or resetting operation may be initiated until the signalling means release the counter when the correct position has been assumed.

FIG. 6 shows a digit wheel 2*a* having a wheel body formed with teeth 20*a* and open-bottomed tooth spaces. A detent wheel 21 is provided with a cardioid cam 3*a* and a feeler-receiving groove 15*a*. This two-part design may be used in subtracting counters, which are adapted to be reset to presettable counts.

FIGS. 7 shows also a digit wheel 2*b* having a circular series of teeth 20*b*, a feeler-receiving groove 15*b* and a cardioid cam 3*b*. These integral digit wheels may be used in adding counters which can be reset to zero.

FIGS. 8 and 9 show an alternative embodiment of a device according to the present invention in which fingers 14′ are arranged to axially extend into grooves 15. The fingers 14′ are part of a feeler rake 10′ mounted on a shaft 19′ for axial movement with respect thereto. The rakes 10′ are moved axially by a suitable, known solenoid 22. A signaling means in the form of a pressure contact 11′ is arranged so as to be actuated by the axial movement of feeler rake 10′. A projection 23 is provided on the feeler rake 10′ to engage bridge 7 and prevent its return when fingers 14′ are unable to axially move into the grooves 15. Rake 10′ is guided for axial movement by guide pins 18′. An abutment ring 24 is provided to limit the movement of feeler rake 10′ in FIG. 8. The spring force of the contact of signaling means 11′ assists in moving feeler rake 10′ from a signaling position back against abutment ring 24. Otherwise, the operation of the embodiment shown in FIGS. 8 and 9 is similar to that for the embodiment shown in FIGS. 1 through 5.

FIG. 10 shows a schematic diagram of a circuit which may initiate another zero-setting or resetting operation when signaling means 11 or 11′ has not been operated. This circuit has a known acknowledgement signal module 25 for initiating such operations. FIG. 10 shows zero-setting solenoid 22 being used to perform the zero-setting or resetting operation. A known counter 26 for counting zero-setting errors is also provided. Counter 26 receives counting pulses from module 25 to register the number of zero-setting errors when there are errors in the zero-setting. The circuit also includes relay s_1,s_2 which provides a short pulse in response to a correct resetting operation and a continuous signal in response to a zero-setting error.

What is claimed is:

1. A pulse counter, which comprises

a plurality of rotatable digit wheels,

a pinion bridge carrying pinions and tending to assume an operative position, in which said pinions are in mesh with respective ones of said digit wheels and operable to rotate the same, said pinion bridge being movable from said operative position to an inoperative position, in which said pinions are disengaged from said digit wheels,

resetting means operable to move said pinion bridge to and hold it in said inoperative position and to rotate said digit wheels to a predetermined reset position,

feeler means engageable with said digit wheels and said pinion bridge and operable to a reset-confirming position when, and only when, said digit wheels and said pinion bridge are in said operative position, and

indicating means adapted to derive from the position of said feeler means an indication when said feeler means are operated to a position short of said reset-confirming position

2. A pulse counter as set forth in claim 1, in which said predetermined reset position is the zero position of said digit wheels.

3. A pulse counter as set forth in claim 2, in which

each of said digit wheels comprises cam means which are engageable by said resetting means so as to rotate said wheel, and recess, which is in a fixed relation to said cam means and adapted to receive said feeler means when said digit wheel is in said predetermined reset position.

4. A pulse counter as set forth in claim 3, in which said cam means comprise a cardioid cam.

5. A pulse counter as set forth in claim 3, in which said recess is a groove.

6. A pulse counter as set forth in claim 2, in which

each of said digit wheels is formed with teeth in mesh with the respective pinion and tooth spaces between adjacent ones of said teeth and further including a recess which is a continuation of one of said tooth spaces.

7. A pulse counter as set forth in claim 6, in which said recess is open-bottomed.

8. A pulse counter as set forth in claim 1, in which said feeler means comprise an integral feeler rake.

9. A pulse counter as set forth in claim 8, in which said feeler rake is a bellcrank lever.

10. A pulse counter as set forth in claim 1, in which said feeler means comprise feeler fingers, which are engageable with respective ones of said digit wheels in a position in which said fingers extend radially with respect to said digit wheels.

11. A pulse counter as set forth in claim 1, in which said feeler means comprise feeler fingers, which are engageable with respective ones of said digit wheels in a position in which said fingers extend axially with respect to said digit wheels.

12. A pulse counter as set forth in claim 1, in which said digit wheels when in another than said predetermined reset position and said pinion bridge when in another than said operative position are have means for blocking the movement of said feeler means to said reset-confirming position.

13. A pulse counter as set forth in claim 12 wherein said indicating means is a signal-generating means operable by said feeler means to generate a signal when, and only when, said feeler means are operated to said reset-confirming position.

14. A pulse counter as set forth in claim 1, in which said resetting means are manually operable and arranged to perform a return movement when they have been operated and means connected to said resetting means and said feeler means for operating said feeler means during said return movement.

15. A pulse counter as set forth in claim 1, which comprises a solenoid for operating said feeler means.

16. A pulse counter as set forth in claim 1, in which

said resetting means have a normal initial position and are arranged to perform a return movement when they have been operated and

said feeler means are connected to means for limiting said return movement of said resetting means short of said initial position when said feeler means have been operated to a position short of said reset-confirming position.

17. A pulse counter as set forth in claim 16, wherein said means for limiting comprises a resilient pawl mounted on said feeler means for pivotal movement and connected to said resetting means to enable an operation of said resetting means independently of said feeler means and to transmit said return movement of said resetting means to said feeler means to operate the same.

18. A pulse counter as set forth in claim 1, in which said indicating means comprise signal-generating means arranged to generate a signal when said feeler means are operated to a position short of said reset-confirming position.

19. A pulse counter as set forth in claim 18, which comprises

a stop arranged to limit the movement of said feeler means in a direction away from said digit wheels and pinion bridge and in which

said signal-generating means comprise resilient means tending to urge said feeler means from said reset-confirming position against said stop.

20. A pulse counter as set forth in claim **18**, which comprises means arranged to operate said resetting means in response to said signal.

21. A pulse counter as set forth in claim **18**, which comprises a counter arranged to count said signals.

* * * * *