Rotary telephone dials—two families—
their looks and sounds

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ABSTRACT

The "rotary" telephone dial was once ubiquitous in our telephone experience. In the US and Canada, most of those fell into two different families, with substantial differences in the principles of their mechanisms. There is a prominent visual clue that lets us distinguish between the families. But they also make dramatically different sounds during their operation.

This article describes the construction and operation of the two types of mechanisms, and tells how they get their distinctive "looks" and "sounds".

1 INTRODUCTION

1.1 The pulse address signaling scheme

From the earliest days of the widespread introduction of "automatic" telephone systems through about 1960, the way that *address signaling* (that is, the transmission of the number of the called telephone) on telephone subscriber lines was by way of pulse signaling. Each digit of the number was represented by a series of "pulses", which were short periods in which the telephone line (normally closed through the telephone set at the calling station) was open-circuited. These pulses were at a rate of nominally 10 per second (and the duration of the pulse was typically on the order of 60% of the pulse period).

The digit "1" was represented by 1 pulse, the digit "2" by 2 pulses, and so forth; the digit "0" (which could hardly have had zero pulses) was represented by 10 pulses.

1.2 The telephone dial

Under most circumstances, these trains of pulses were generated by what came to be known as the telephone "dial", a passive electrometrical device manipulated by the caller.

Typically, as the design "matured", the dial had a round "finger wheel" with ten holes of a diameter through which most people could put their index finger, at least partway. The holes were labeled (perhaps on a plate beneath the finger wheel) with the digits 1 through 9 and then 0.

The user would put his finger into the hole for the digit to be "dialed" and turned the finger wheel clockwise until the finger hit a curved, stationary "finger stop" Doing so wound up a spring inside the dial.

The user then removed his finger, allowing the wheel to turn freely in the counterclockwise direction under the force of the spring. The speed at which it returned was controlled by a mechanical friction "flyball" governor.

As the wheel returned, a mechanism periodically opened an electrical contact, generating the series of "open circuit" pulses that corresponded to the digit being dialed.

1.3 Perspective

The descriptions here are from the perspective of the practice in the US and Canada. Dials made for use in other parts of the world often follow one or the other of the two mechanism schemes I will describe here, perhaps with significant change in detail. But I will not be going into that.

2 TWO FAMILIES

For the most part, the rotary dials used in the US and Canada fall into two families, differing in the overall approach of their mechanisms.[1]

The first family is exemplified by the dials made, over the years, by what was at one time known as Automatic Electric Company (a major manufacturer of telephone equipment mostly for the non-Bell part of the US telephone business, later absorbed into GTE). These were for the most part used by non-Bell telephone companies. I will often refer to these as the "AE" dials for short.

The second family is exemplified by the dials made, over the years, by Western Electric Company (the "internal" manufacturer of the Bell Telephone System)[2]. These were for the most part used by Bell Telephone System companies. I will refer to these as the "WE" dials for short (but, as we will see later, there is a subdivision of that family into two "epochs", which I will specifically abbreviate as "WE1" and "WE2").

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[1] Actually, most rotary dials used world-wide had mechanisms that fall into one of these two "families", exactly or "generally".

[2] In Canada, these were probably made by Northern Electric, Western Electric's "Canadian Cousin", but were essentially identical to the Western Electric ones.

3 THE MECHANISMS

3.1 The Automatic Electric family dials

3.1.1 *From the front and rear*

These figures show a typical Automatic Electric dial from the front:

Figure 1. Typical Automatic Electric dial—front

and from the rear (with various parts labeled for future reference):

Figure 2. Typical Automatic Electric dial—rear

3.1.2 *Basic operation*

When the finger wheel is rotated, it winds up a coil spring. When the finger wheel is released (after the user had turned it until his finger hit the finger stop), the spring motivates the wheel to return to its "home position". As it does, a train of pulses (representing the digit "dialed") is generated.

3.1.3 *Control of the return speed*

The pulse cam shaft operates, through a stage of spur gearing to an intermediate shaft and then a "reverse worm" gear stage, a frictional flyball governor, with two weights mounted on flat springs. As the governor begins to rotate at the beginning of rundown, as its speed increases, the two weights, acting against the flat springs on which they are mounted, move a bit outward.

When the governor shaft reaches essentially the speed corresponding to the desired rotational speed of the main shaft, the weights have moved outward enough that friction pads on the weights contact the inside of the metal cup within which the governor rotor rotates, slowing the shaft. The system reaches a dynamic equilibrium with the governor shaft rotating at the speed that makes the main shaft turn at the desired speed.

3.1.4 *Generation of the pulse train*

The intermediate shaft referred to just above also carries a cam (the "pulsing cam") having two lobes. That shaft rotates once for the amount of rotation of the main shaft corresponding two "holes" of the finger wheel. Those lobes can hit one spring of a contact spring set (the "pulsing contact"), momentarily opening that contact, creating a "pulse".

3.1.5 *The ratchet mechanism*

Of course as the dial is being "wound up" for a digit, we do not want the pulse cam and pulse contact to generate pulses, nor do we want the governor intervening in the process. Actually, the gear that drives the pulsing cam shaft (the "main gear") rides freely on the main shaft. Attached to it is a wheel with 13 fat square teeth. We see this (barely visible) on the following figure.

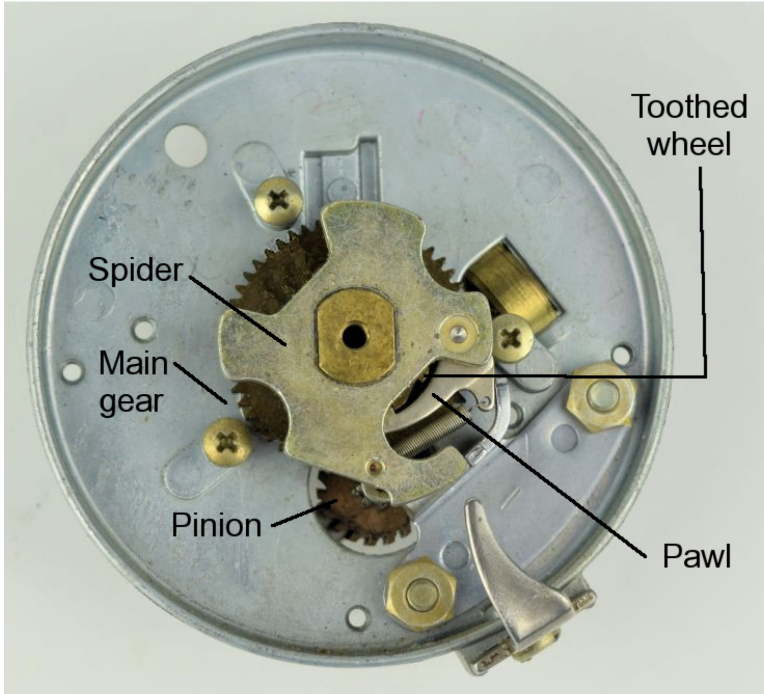

Figure 3. Typical Automatic Electric dial–internals

On the main shaft itself (driven by the finger wheel) there is a plate (I call it the "spider") that carries a pawl that can engage the teeth on the toothed wheel wheel, making a ratchet arrangement so the toothed wheel (and the main gear) can only be turned in one direction by the rotation of the main shaft.

As the finger wheel is "wound up", the pawl runs freely over the teeth, the main gear does not rotate, the governor is not driven, and the pulse cam does not rotate.

Of course, when the wheel is released, the pawl engages the first handy tooth on the toothed wheel, and from then on everything rotates.

3.1.6 *The impulse shorting arm*

The nominal amount that the dial is wound up for any given digit is such that the pulse cam shaft rotates one more half revolution than the number of pulses that are needed for that pulse. But the last half revolution does not generate a pulse. Here's why.

When the dial is at or near its home position, a cam arm (called the *impulse shorting arm*) on the main shaft lifts the normally-fixed spring of the pulse contact, assuring that the pulse contact will then be closed even when the pulse cam makes its last attempt to generate a pulse. (See the location on Figure 22, and operation on Figure 4.)

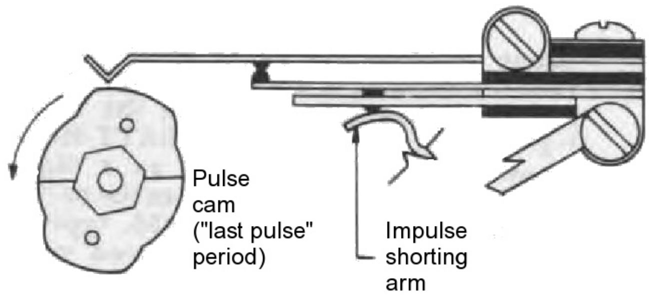

Figure 4. Impulse shorting arm mechanism

The object is to introduce an additional one pulse time (0.1 second) to the minimum delay between digit pulse trains. This minimum delay is needed so that the central office equipment can clearly distinguish which pulses are part of which digit.

This scheme is in part responsible for the substantial “dead space” between the holes in the layout of the finger wheels of the Automatic Electric family of dials (three hole spaces.

3.1.7 *The off-normal contacts*

This topic does not at all effect the central theme of this article, the “sight and sound” of the two dial families. But it is an important part of overall dial operation, and its implementation is prominent in the pictures of both dial mechanisms I show here. So I thought I would take a while to discuss it.

I refer to what are usually called “off normal” contacts. When the dial is in its “normal” (“home”) position, a cam arm on the main shaft presses on those contacts, holding them in what we consider the *released* state (since it is the state they are in with the dial “idle”.) As soon as the dial leaves the home position as it is being wound up, those contacts are considered to be *operated*. The are put in the released state again once the dial returns to the home position.

In most telephone sets in which these dials were used, one contact in this set, when the contacts are operated (when the dial becomes “off normal”), short circuits the transmission circuit of the telephone set. This removes the resistance of the transmission circuit from the “loop” closure on the telephone line. This increases the line current (between open pulses, of course) during the transmission of the train of pulses for the digit, making it easier for the responding relay at the central office to correctly follow the pulses.

We might think that this would also take care of another problem. If nothing else happened during the transmission of the train of pulses, each time the pulsing contact opens, and then again when it closes, the sudden loss and then resumption of the DC current in the transmission circuit would each cause a serious “pop” to be created in the telephone set receiver. With the transmission circuit short-circuited by the off-normal contact during the transmission of the train of pulses, this phenomenon would be eliminated.

But it would be replaced by another, albeit not so great, problem. When the short circuit is applied across the transmission circuit as the dial was wound up, the abrupt loss of DC current flow in the transmission circuit itself makes a pop. And when the short-circuiting contact opens when the dial returns to normal, the resumption of DC current in the transmission circuit causes another pop.

So if we think of a dialed digit “3”, now instead of 6 pops in the user’s ear there were only 2. Not yet good.

So what was done was to have another contact in the off-normal contact group that also closes when the dial is off normal. This short-circuits the receiver so it is muted (without any pop—there is no DC voltage across the receiver circuit) at the beginning of dial operation. (The contacts are arranged so the receiver muting contact closes before the transmission circuit shorting contact closes.)

3.1.8 *Identification*

AE dials can be distinguished from those of the other family described here, the WE dials, visually (their finger wheels are laid out rather differently than the finger wheels on the WE dials) and aurally, the AE dials making a wholly different sound in operation than the WE dials. Descriptions of both of those are coming right up.

3.1.9 *Finger wheel layout*

AE dials almost exclusively used a finger wheel such as we saw in Figure 1. The 10 finger holes are on a pattern of 13 equally-spaced positions (3 of which of course have no hole). The “0” hole is at exactly 6 o’clock. This is easily distinguished from the finger wheel layout of the typical WE dial, seen in Figure 5, below.

3.1.10 *The sound*

I will first assume an Automatic Electric original Type 24 dial (the earliest major member of the AE family as we will discuss it)[3].

As the finger wheel is wound up for a digit, no gears are turning, and all we hear is the series of “snaps” as the pawl goes over each tooth of the toothed wheel and drops.

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[3] Introduced in 1924.

When the finger wheel is released, we first hear a “snap” as the pawl reaches and then hits the first handy tooth on the toothed wheel. From then on, we hear the gear noise (a gentle “purring” in this case), but not much else.

3.1.11 *The newer sound*

In Automatic Electric dial Type 24A36 [4], there is a cushion spring on the pawl so that as the dial is being wound up, as the pawl comes to the end of each tooth and drops, it makes a “soft lending”, replacing with a soft “plop” the sharp “snap” sound that would otherwise be made as each tooth is passed. Thus the overall sound while the dial is being wound up is much softer.

3.1.12 *The even newer sound*

In the Automatic Electric Type 51 dial (introduced in 1951[5]), and successive types, an ingenious mechanism completely eliminates the train of pawl sounds as the dial is wound up.

The spider operated by the finger wheel carries, in addition to the pawl mentioned before, a small metal latch (formally, the “pawl lever”), which can rotate a short amount (with respect to the spider) on the main shaft. With the finger wheel turning clockwise, friction between that latch and the main gear (a friction washer there) causes the latch to lag behind the rotation of the spider. The latch then comes into contact with a feature on the pawl.

As soon as the pawl climbs up on the first tooth of the driven plate, the latch moves in, and prevents the pawl from dropping when it comes to the end of that tooth. Thus the pawl noise on windup is completely eliminated.

When the wheel is released, the friction of the latch against the main gear as it moves to catch the first tooth is in the direction that moves it out of contact with the pawl, which is then free to catch that first tooth.

The result is that these “Type 51+” dials, when being wound up, are almost eerily silent. But when released, we still hear a snap when the pawl catches that first tooth (a bit quieter than before) and then a gentle purring sound as the dial runs down.

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[4] An improved form of the Type 24, introduced in 1936.

[5] Are you beginning to see a pattern here?

3.1.13 *The Automatic Electric Type 52 dial*

Automatic Electric made a telephone set (Type 80E) with much the style of the Western Electric 500-type telephone set, with a new dial design, the Type 52 [6]. As with the Western Electric 7-type dial (see Section 4.5), the number plate extended outside the finger wheel, and the digits (and associated letters) were outside the finger wheel. As with the dials of the rest of the AE family, the finger plate was laid out as seen in Figure 1.

The mechanism of this dial is essentially as previously described for the other AE dials.

3.2 The Western Electric family dials—Epoch 1

3.2.1 *The two epochs*

The evolution of the family of Western Electric dials can be subdivided into two “epochs”, which I call Epoch 1 for dials introduced before 1950 and Epoch 2 for dials introduced from 1950 on.

Within each epoch, the mechanisms are quite similar, but between the two epochs there are significant differences in the mechanism principles. When I use the abbreviation “WE1”, dials of Epoch 1 are implied; with regard to the dials of Epoch 2, I will use the abbreviation “WE2”.

3.2.2 *From the front and rear*

These figures show a typical Western Electric dial (either epoch) from the front:

[6] Introduced when? You guess.

Figure 5. Typical Western Electric dial—front

and a typical Epoch 1 (WE1) dial from the rear (with various parts labeled for future reference):

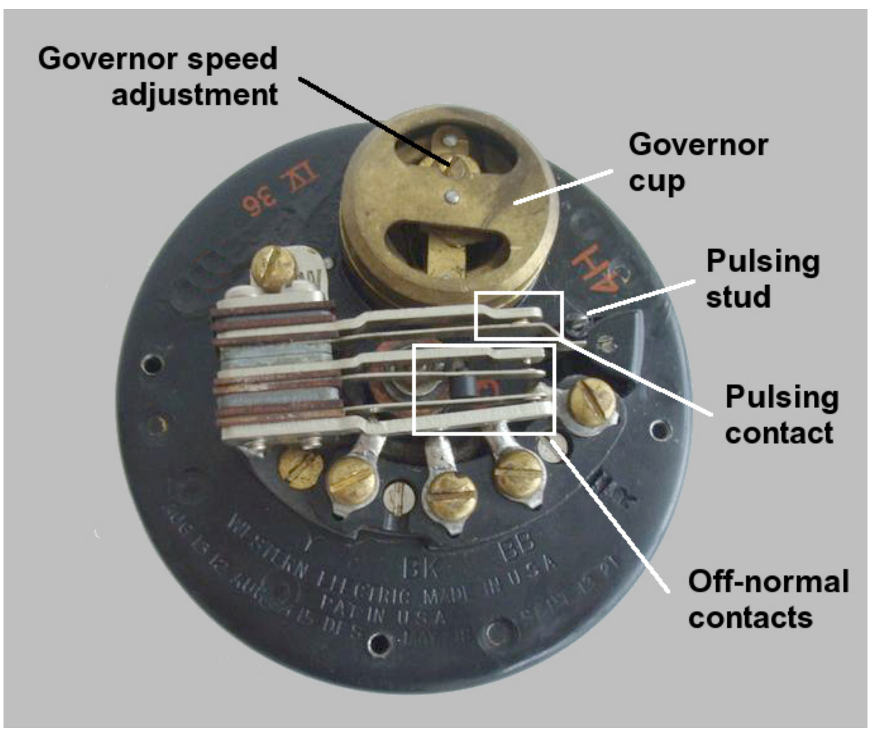

Figure 6. Typical Western Electric Epoch 1 dial—rear

3.3 Types included

Dials using the mechanism I discuss here (under Epoch 1) include the Western Electric 1-, 2-, 4-, and 5-types.

3.3.1 *Basic operation*

When the finger wheel is rotated, it winds up a coil spring. When the finger wheel is released (after the user had turned it until his finger hits the finger stop), the spring propels the wheel to return to its "home position". As it does, a train of pulses (representing the digit "dialed") is generated.

3.3.2 *Control of the return speed*

The finger wheel is on a shaft (the "main shaft") that, for one thing, goes through a "speed up" chain of spur gears to the shaft of a frictional fly ball governor, with weights pivoted on a bar driven by the shaft. At the beginning of rundown, as the speed of the governor increases, the two weights, acting against springs in the governor. move a bit outward.

When the governor shaft reaches essentially the speed corresponding to the desired rotational speed of the main shaft, the weights have moved outward enough that friction pads on the weights contact the inside of the metal cup within which the governor rotor rotates, slowing the shaft. The system reaches a dynamic equilibrium with the governor shaft rotating at the speed that makes the main shaft turn at the desired speed.

3.3.3 *Generation of the pulse train*

We see the arrangement in this figure:

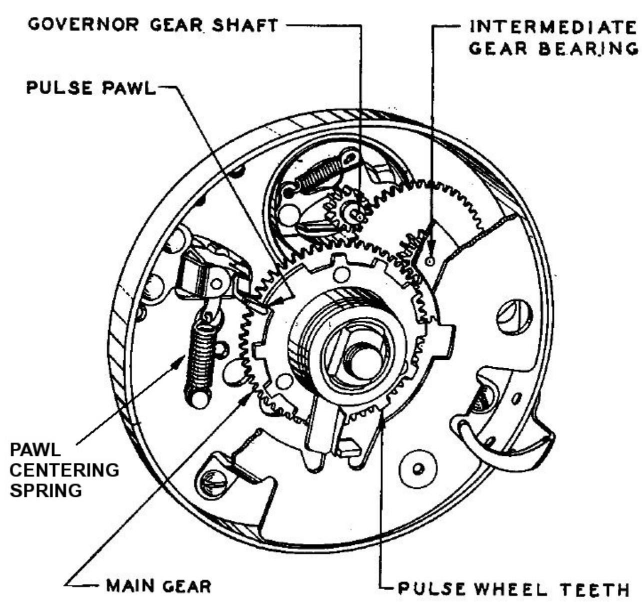

Figure 7. Typical Western Electric Epoch 1 dial–internals

The main shaft carries a pulse wheel with 10 square teeth on it, spaced on a 12-to-the-revolution basis (matching the locations of the holes in the finger wheel), plus a wider tooth. There is a spring-centered pulse pawl whose tip can be moved by those teeth.

As the dial is being “wound up” for a digit, these teeth strike the pawl, turning it in the counterclockwise direction (as we see it). An insulated extension of that pawl (the “pulsing stud”), passes through an opening in the back of the case of the dial, but when the pawl moves in this direction it has no effect on the contact springs there.

As the dial “runs down”, the teeth also strike the pawl, this time rotating it clockwise. Now the pulsing stud pushes a contact spring to open the pulse contact. This is how the pulses are created.

3.3.4 *The governor ratchet*

Of course, as the dial is “wound up” by the user for the digit of interest, we do not want the governor interfering. Accordingly, the governor drive gear is coupled to the governor rotor through a ratchet wheel and pawl mechanism in the governor proper.

Thus, as the dial is “wound up”, this does not drive the governor.

3.3.5 *The off-normal contacts*

The background for this is discussed in connection with the AE dials in section 3.1.7. Indeed, the common forms of the WE dials also have a set of off-normal contacts (seen in Figure 6). In the form used in telephone sets, one of those contacts, just as earlier described, makes when the dial is off-normal (away from its “home” position) so as to short-circuit the transmission circuit.

And, as before, a second off-normal contact mutes the receiver when the dial is off-normal. But in this case (in general), this is a contact that opens, and is in series with the receiver (the opposite of the common AE arrangement).

As before, the off-normal contacts are arranged so that the receiver muting contact reliably opens before the transmission circuit shorting contact closes.

3.3.6 *Identification*

WE dials can be distinguished from the other species described here, the AE dials, visually (their finger wheels are laid out rather differently than the finger wheels on the AE dials) and aurally, the WE dials making a wholly different sound in operation than the AE dials. Descriptions of both of those are coming right up.

3.3.7 *Finger wheel layout*

The finger wheel of the typical WE dial (see Figure 5) has 10 holes on a circle of 12 positions, with the “0” hole at an angle of 45° counterclockwise from the very bottom. This is readily visually distinguishable from the layout of the typical AE dial (see Figure 1).

3.3.8 *The sound*

As the dial is being would up for a digit, the gear train that drives the governor is under a very slight load, but enough that we hear the “gear” sound. And we hear the train of small clicks made by the ratchet drive in the governor. Also, as the teeth of the pulse wheel repeatedly turn the pawl in its “does nothing” direction and then release it, each time we hear a small “snap”.

As the dial runs back to home, the gear train to the governor is under significant load, and so we hear the gear noise, And each time a tooth of the pulse wheel operates the pawl, we hear a “snap”. The entire “recital” is very distinctive.

3.3.9 *The new sound*

In the earliest 5-type dials, a new feature reduced the clicking sound caused by the pawl as the dial was wound up. We see the mechanism in this figure:

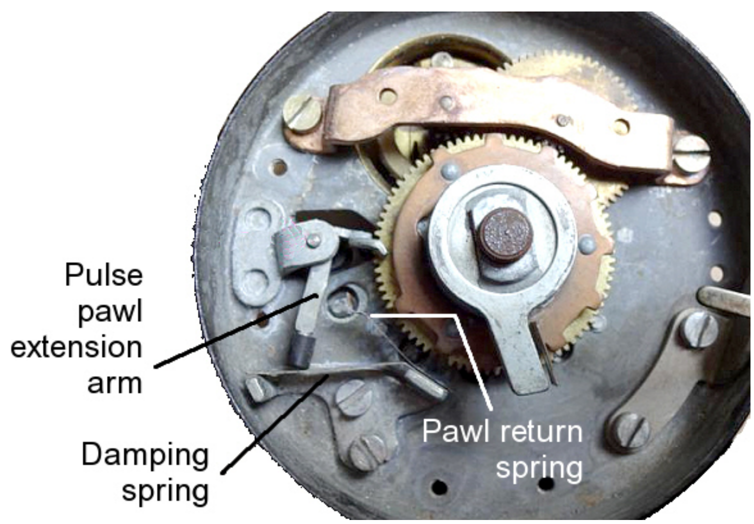

Figure 8. 5-type dial—pulse pawl mechanism

Adapted from a photo by Dennis Markham

Now, the pulse pawl now has an extension arm with a plastic tip. which rides on a small flat “damping spring”. The pawl return spring (hard to see in the picture) returns the pawl when, during wind-up, the pawl comes “off a tooth”. But the damping spring catches the pawl (in a “soft landing” way), greatly reducing the sound that was made.

The pawl drops down just enough that, when the pulse wheel starts to turn in the "run-down" direction, the first tooth would be able to catch the pawl and move it through its neutral position (where we see it in the figure) to the "operated" position, so a pulse would be generated in the usual way. Subsequent pulses are generated with the pawl starting from the neutral position.

This mechanism, while clever and (when behaving well) effective, was "fussy" to adjust, and dirt collecting on the damping spring would make the operation erratic.

Accordingly, in later 5-type dials, a different scheme altogether was used. Here, the pulsing pawl is molded plastic, which alleviates the sound caused by the pawl as it rides over the teeth of the pulse wheel when the dial is belong wound up. A different type of pawl centering spring is used here than before. We see this mechanism here:

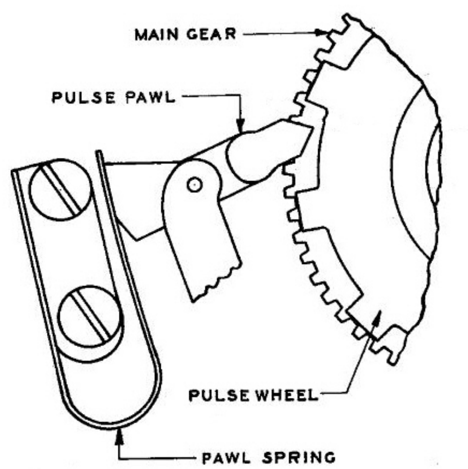

Figure 9. 5-type dial—molded pulse pawl

A further change made in the 5-type dials was the replacement of the ratchet and pawl mechanism (used to prevent the governor from being driven in the "wind up" direction of the dial), used in the earlier types, with a spiral band one-way clutch. This is silent in its operation, eliminating another of the sources of "clicking" as the dial is wound up.

4 WESTERN ELECTRIC DIALS—EPOCH 2

4.1 Introduction

The discussions so far of this family cover the Western Electric dials that were designed up through the late 1940s ("Epoch 1", WE1 for short).

In the late 1940s, Bell Telephone Laboratories developed a wholly new dial mechanism that was used in dials of a new physical form (the

7-type dial) to be used in the dramatically new telephone set being developed at the time (the 500-type telephone set, essentially introduced in 1950), and was (just a little later) also used in dials (the 6-type dial) that were physically and electrically interchangeable with the 4- and 5-type dials of Epoch 1, and so could replace them. I refer to the various dials with this new mechanism as “Western Electric Epoch 2” dials (“WE2” for short).

The new mechanism had numerous advantages in consistency of performance, ease of manufacture, and durability.

4.2 The mechanism

4.2.1 *Overview*

We see the overall Epoch 2 mechanism layout in expanded form in the following illustration:

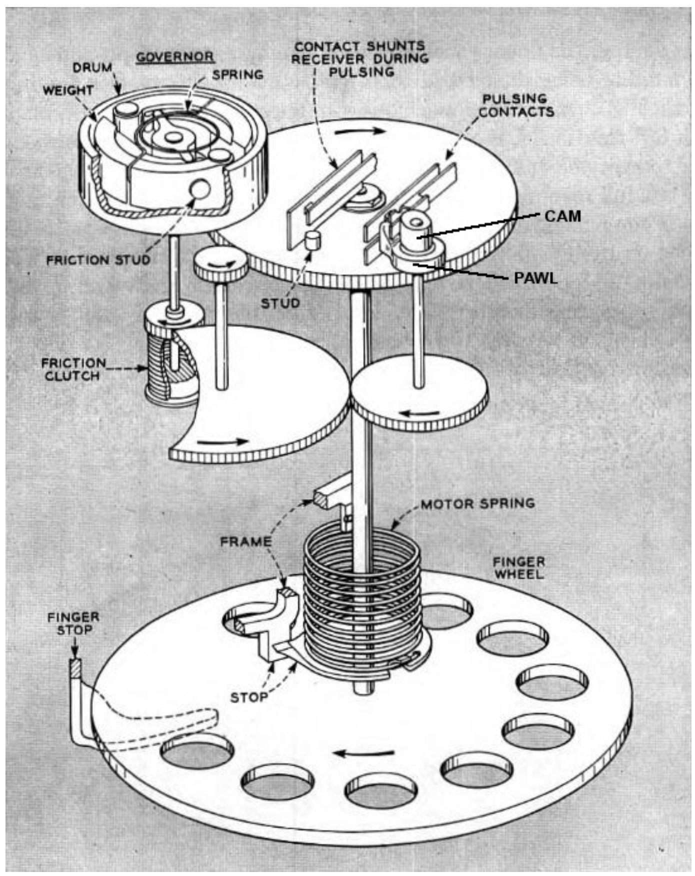

Figure 10. Western Electric Epoch 2 (WE2) dial mechanism

4.2.2 *Basics*

As with the WE1 dials, there is a coil spring acting on the finger wheel shaft that tries to turn the finger wheel back to the “home” position when it is released. Also as before, the finger wheel shaft is connected through two-stage spur gearing to the governor shaft. And, as in the 5-type dials, a spiral band one-way friction clutch is used between the final gear and the governor shaft to prevent the governor from intruding into the wind-up operation. But here it is external to the governor.

4.2.3 *The governor*

The governor is of the general shape of the former governor and at first glance seems to be of the same general construction (just a bit heftier). But there are significant changes in the mechanical details that result in this type of governor being far more consistent and stable than the governors in the WE1 dials. (The details are beyond the scope of this article.)

4.2.4 *Pulse generating mechanism*

Another major change is in the pulse generating mechanism. Rather than it being operated by a wheel with multiple teeth on the finger wheel shaft (as with WE1 dials), this pulse generator runs from a shaft driven by a spur gear pair from an intermediate gear that is part of the governor drive train. This shaft rotates once for each “hole pitch” of the finger wheel.

We see the pulse generating mechanism close-up in this figure:

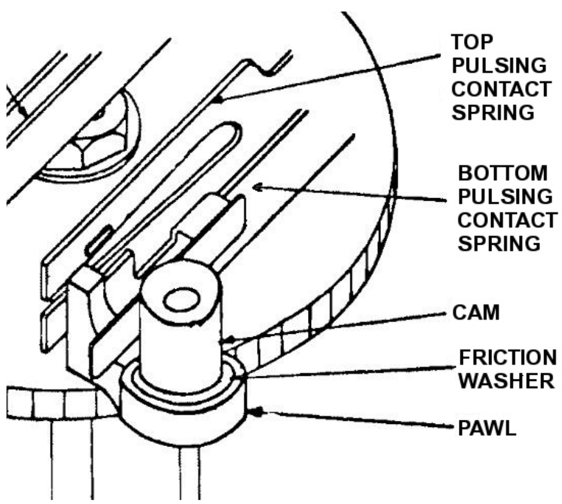

Figure 11. Pulse generating mechanism

A nylon cam on that shaft operates on an extension of the bottom pulsing contact spring to move that spring up and down. There is also a pawl on the shaft, “lightly” driven by friction from the cam through an intervening friction washer. That pawl, if in a certain position (labeled “Position 2” in the following figure), can hold the top pulsing contact spring in an “up” position.

I will work from this figure to discuss the operation:

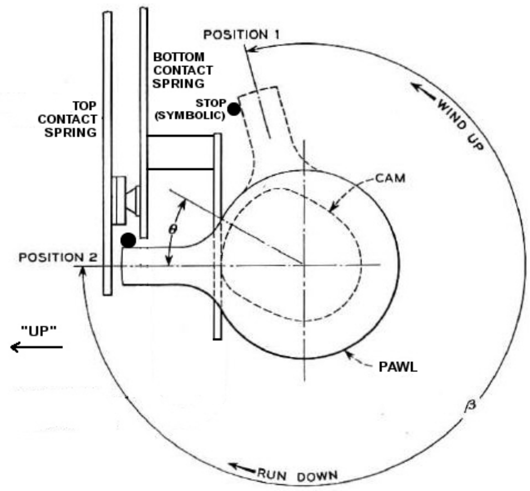

Figure 12. Pulsing mechanism in operation

During windup, by the time the cam moves (counterclockwise) from its rest position (where it is shown on the figure) enough that the bottom contact is “dropped” by the cam lobe, the friction coupling between the cam and the pawl has swung the pawl counterclockwise from Position 2 far enough that it cannot hold the top contact spring from also dropping. (As the shaft rotates further, the pawl is swung until in Position1 it hits a stop, represented symbolically in the figure.)

Thus, during windup, the cam pumps the bottom contact spring down and up, but the top contact spring just rides down and up on it, the contacts never opening. In fact, during this part of the operation, the contacts on the ends of the two springs “scrub” a little on each other, assuring that a “reliable make” was preserved.

When the finger wheel is released, and the various shafts began turning in the “run-down” direction, the friction coupling swings the pawl until (after a rotation of the shaft of over 3/4 of a revolution) it hits the stop at Position 2. In this position, it **can** hold the top contact spring in the “up” position.

As a consequence, subsequently, as the cam pumps the bottom contact spring down and up, the contacts open and close, generating the pulses for the digit dialed.

4.2.5 *The first pulse—not*

However, the position of the cam at the end of the typical windup (where the finger would be expected to hit the stop), and the position of the position of the pawl after wind-up (position 1), are such that the first time the lobe of the pulsing cam lowers the bottom pulsing contact spring, the pawl has not yet moved into the position where it will hold the top contact spring up.

Thus both springs drop together, and the pulse that "should" happen just as the return of the finger wheel begins does not happen. The first pulse actually happens during the **next** revolution of the shaft, when the pawl has already come to position 2. This delay assures that, by the time the first pulse is actually generated, the speed of the governor will have stabilized.

This delay also assures that, if the user were especially speedy in his finger movements, there would still be a certain minimum delay between the last pulse of one digit and the first pulse of the next digit, needed so the central office could ascertain which pulses are part of each digit.

4.3 The off-normal contacts

The 7-type dial was used in the Western Electric 500-type telephone set (introduced in 1950). There, when the dial is off-normal, the transmission circuit is not short-circuited (it having been determined that this was no longer necessary, for various reasons). Thus the off-normal contact that might have done that was not provided in the common version of this dial.

In addition, here the receiver is muted when the dial is off-normal by short circuiting it (just as had been earlier discussed in connection with the use of the AE dials), rather than by opening the circuit to it, as was done in most earlier Western Electric telephone sets. (The reasons for this, although fascinating, are beyond the scope of this article.) Thus the receiver-muting off-normal contact closes, rather than opens, when the dial is off-normal.

4.4 Identification

Western Electric dials of this epoch can still be readily distinguished from Automatic Electric dials in two major ways.

4.4.1 *Visually*

Dials of this epoch use a finger wheel whose layout is just the same as seen in Figure 5.

In the 7-type dial (used in the 500-type telephone set), the number plate (behind the finger wheel) extends substantially outside the finger wheel, and the digits (and associated letters) are outside the finger wheel.

4.4.2 *The sound*

During windup, all we hear is the gear noise, which however is substantial. The gears are metal, and there is a bit of a load through them and through the clutch to the governor. But there is absolutely no clicking (since no pawl rides over teeth). And the operation of the pulse generator (including during windup) is essentially silent.

During rundown, again we hear the gear noise, now perhaps a bit greater due to the load afforded by the governor. There is no clicking sound, and the operation of the pulse generator (now in its actual pulse generating mode) is still essentially silent.

Despite these changes. the overall sound os not greatly different from that of the WE1 dials, and is of course still dramatically different from the sound of the AE dials, even in their own later evolutionary forms.

4.5 Later generations

Later, new generations of dials with essentially this mechanism were designed for application to various types of telephone set. Discussion of them is beyond the scope of this article.

5 OTHER MANUFACTURERS

In the earlier part of this article I spoke of one of the dial families, for example, as “exemplified by the dials made by Automatic Electric Company”, and similarly for the dials made by Western Electric.

That language was intended to recognize that dials following both of those mechanism schemes were also made (in the US) by other companies, prominently including (and here I will use one concise form of their names, which all changed over the years) Stromberg-Carlson, Leich Electric, ITT, Kellogg Switchboard and Supply, and North Electric.

Most of these dials were essentially “clones” of either the Automatic Electric or Western Electric dials, likely in many cases made under patents of those two companies.

The whole matter is greatly complicated by the various entanglements, mergers, acquisitions, renamings, and the like among these companies.

Further discussion of any of this is beyond the scope of this article.

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