

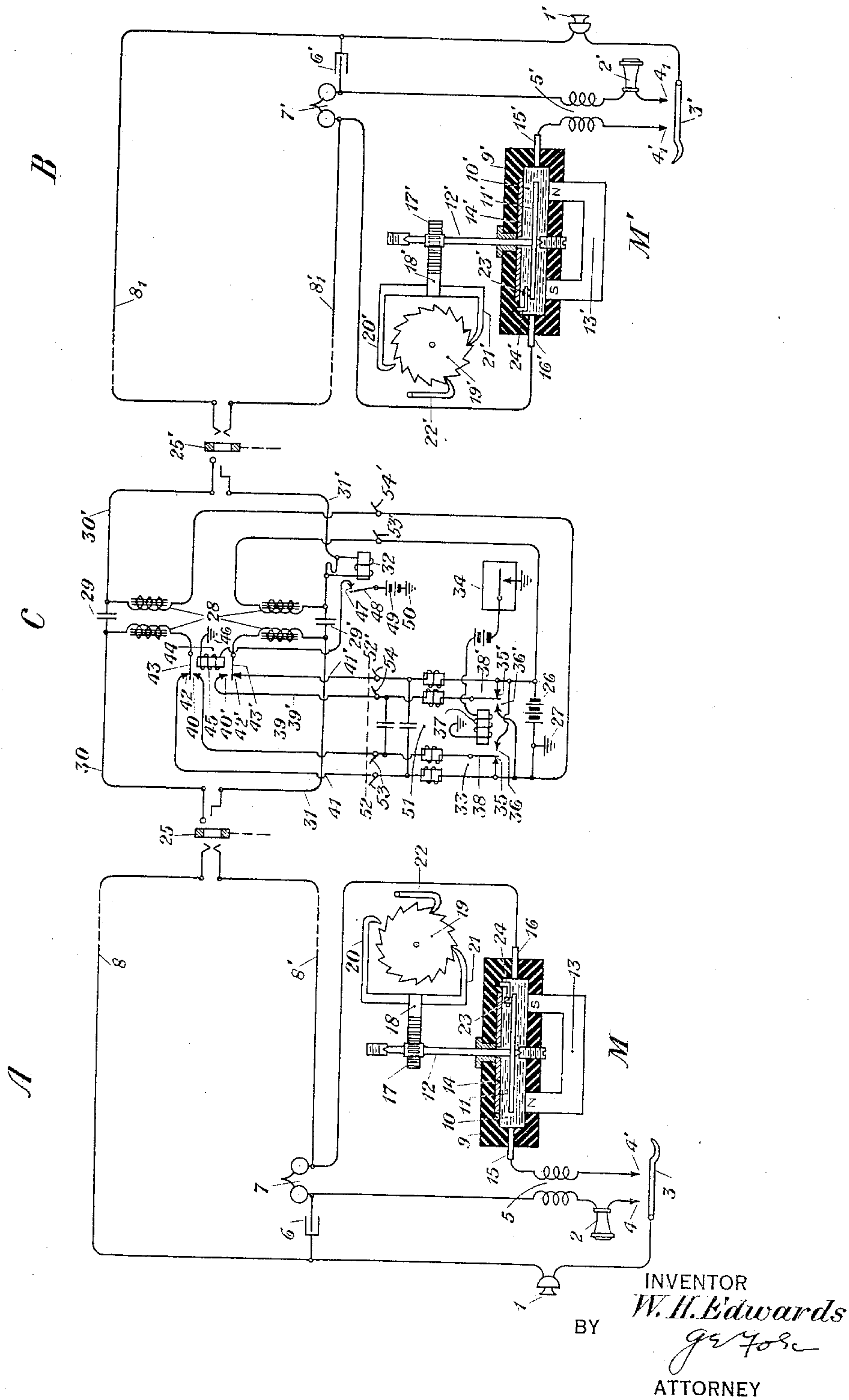
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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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This invention relates to telephone systems and more particularly to a telephone system having a mercury motor meter located at the subscriber's station for measuring the length of time the telephone is in use.

Heretofore it has been proposed to measure the length of time the telephone is in use by providing at the subscriber's station a direct current motor meter of the coil armature type.

In order to render this type of motor responsive to the small current normally flowing in the telephone circuit, it was found necessary to provide a motor of complicated structure and of very fine adjustment, thus rendering it very expensive in initial cost and subsequent maintenance. Also, the friction caused by the constant contact of the commutator brushes with the moving commutator bars, and by the rotation of the relatively heavy armature on its bearings, seriously decreased the efficiency of the motor and necessitated frequent replacement of parts. Furthermore, in order that the motor rotate at a constant speed, it was necessary to provide some sort of mechanical means, such as a centrifugal governor, to regulate its speed. Obviously, the use of such means necessitated extremely accurate and frequent adjustment, and at the same time rendered said motor less sensitive to the small current in the circuit.

According to this invention a telephone metering system is provided which includes a motor meter which is simple and rugged in structure, inexpensive in initial cost and subsequent maintenance, sensitive to the small current present in the telephone circuit, and accurate in operation, regardless of current variations in the line.

A better understanding of the invention may be had from the detailed description hereinafter following.

The drawing represents diagrammatically a telephone system illustrating one embodiment of the invention.

In the drawing two subscribers' stations A and B are shown with subscribers' loops extending to the central office and terminating in the jacks 25 and 25'. As shown A represents the station of calling subscriber and B that of the called subscriber. Substation A

comprises the usual transmitter 1, receiver 2, receiver hook 3, contacts 4 and 4', induction coil 5, capacity 6, ringer 7, and line conductors 8 and 8'. In addition, there is located at the substation a mercury motor meter M, the armature of which is connected in series with the substation circuit.

The motor meter M includes a receptacle 9, of insulating material adapted to contain a quantity of mercury 10, a disk armature 11 submerged in the mercury and supported by the pivoted shaft 12, a permanent magnet 13 adapted to provide the magnetic field, a plate 14 adapted to provide a return path for the magnetic lines of force, and terminals 15 and 16. As stated above, the armature is connected in series with the substation circuit through terminals 15 and 16. Secured to one end of the shaft 12 is a gear member 17 adapted to move the pawl support 18 back and forth. Each movement of the pawl support 18 rotates the ratchet wheel 19 one step by means of the pawls 20 and 21. A holding pawl 22 is provided to hold the ratchet wheel in its operated position. The position of the pawls 20 and 21, with respect to the teeth of the ratchet wheel, is such that one complete revolution of the armature 11, in either direction, is required in order to operate the ratchet wheel one step. Other means for operating the ratchet wheel only after the armature 11 has completed its full revolution may be used, if desired. There is also provided a bar member 23 secured to the armature 11, and a stop 24 fastened to the receptacle 9. The bar member is adapted to come in contact with the stop when the armature has rotated one complete revolution in either direction, and to prevent its further rotation in that direction. The speed of the armature is adjusted to rotate one revolution on the minimum line current in a predetermined period of time, for example, in slightly less than fifteen seconds. Under the minimum operating current the meter operates continuously for practically the full period, and during said period is moving one of the pawls, 20 or 21, to a position such that it will operate the ratchet wheel one step. On line currents greater than the minimum, the arma-

ture 11 completes its revolution in less than the predetermined period, and consequently completes the registering operation before the end of said period. The bar member 23 reaches the stop 24 at the end of the revolution, and cannot rotate farther in this direction no matter how long the current continues in the same direction. As soon as the current is reversed however, the armature rotates in the opposite direction, and at the end of the revolution another step has been taken by the ratchet wheel. Thus, this invention provides a means for accurately measuring the time the telephone is in use under the worst operating conditions.

The arrangement at substation B is the same as that shown at substation A, and described above.

The cord circuit C of the central office is here illustrated as the impedance coil feed type. Obviously a cord circuit of the repeating coil feed type may be used if desired. The cord circuit shown comprises the usual current source 26, grounded at 27, a current supply bridge comprising impedance coils 28, capacities 29 and 29', cord conductors 30, 30', 31 and 31', and supervisory relay 32. In addition there is located at the central office a current reversing means 33 under the control of the clock mechanism 34. This reversing means comprises the contacts 35, 35', 36 and 36', the relay circuit 37, armatures 38 and 38', the leads 39 and 39', and the contacts 40 and 40'. Normally the impedance coils of the current supply bridge of the calling subscriber's line, are connected directly to the source 26 through the leads 41 and 41', the contacts 42 and 42', and the armatures 43 and 43'. A switching means 44, under the control of relay 32, is provided to associate the current supply bridge of the calling subscriber's line with the source 26 through the reversing means 33. This switch comprises the relay 45 grounded at 46, the armatures 43 and 43', the contact 47, the armature 48, and the source 49 grounded at 50. A filtering element 51, comprising a plurality of choke coils and high capacity condensers, is associated with the leads 39, 39', 41 and 41', to prevent any objectionable disturbances in the talking circuit due to the current reversals.

The operation of the system is as follows: When the subscriber at substation A removes his receiver from the hook to initiate a call, the operator in response to the signal establishes a connection to the central office through the jack 25 in the well known manner. At this time the current flows from the positive terminal of the source 26, through the lead 41, the contact 42, the armature 43, the upper left impedance coil 28, the cord conductor 30, the jack 25, the line conductor 8, the transmitter 1, the receiver hook 3, the contact 4', the induction coil 5, the terminal

15, the mercury 10, the armature 11, the mercury 10, the terminal 16, the line conductor 8', back through the jack 25, the cord conductor 31, the lower left impedance coil 28, the armature 43', the contact 42', and the lead 41' to the negative terminal of the source 26. With this direction of current flow through the armature 11, it tends to rotate, for example, from left to right. However, since the bar member 23 is resting against the stop 24, no rotation can occur, and hence no registration can take place. The operator completes the connection to the called subscriber B and transmits ringing current over the line. Ringing current does not operate the meter of the called subscriber because the receiver hook contacts at the called subscriber's station are normally open. However, even if the called subscriber should remove his receiver from the hook during the transmission of the ringing signals, the meter would not be operated because it is made sufficiently sluggish in operation to prevent its response to the rapid variation of the ringing current, which sluggishness is obtained by requiring the armature 11 to complete one revolution in order to register one step. When the called subscriber removes his receiver from the hook, the circuit, including the relay 32, is closed in the well known manner. The closure of the circuit, and the resulting energization of the relay 32, cause the latter to attract the armature 48 which establishes a connection with contact 47. The establishment of this connection closes the circuit of the relay 45 and causes its energization. When energized, this relay attracts its armatures 43 and 43' to break their connection with contacts 42 and 42', respectively, and to establish their connection with contacts 40 and 40', respectively. This breaks the direct connection of the impedance coils of the current supply bridge of the calling subscriber with the source 26, and reconnects them to said source through the reversing means 33. At this time if the relay circuit 37 is open, the current flows from the positive terminal of the source 26 through the contact 35, the armature 38, the lead 39, the contact 40, the armature 43, the upper left impedance coil 28, the cord conductor 30, the jack 25, out over the subscriber's loop in the same direction as before, back through the jack 25, the cord conductor 31, the lower left impedance coil 28, the armature 43', the contact 40', the lead 39', the armature 38', and the contact 35' to the negative terminal of the source 26. Obviously, no registration of the meter occurs. At predetermined intervals of time, for example, every fifteen seconds, the clock mechanism 34 closes the relay circuit 37, which causes the armatures 38 and 38' to break their connection with contacts 35 and 35', respectively, and to establish their con-

nection with contacts 36 and 36', respectively. This causes a reversal of the current flowing through the line conductors 8 and 8'. The current now flows from the positive terminal of the source 26, through the contact 36', the armature 38', the lead 39', the contact 40', the armature 43', the lower left impedance coil 28, the cord conductor 31, the jack 25, the line conductor 8', the terminal 16, the mercury 10, the armature 11, the mercury 10, the terminal 15, the induction coil 5, the contact 4', the receiver hook 3, the transmitter 1, the line conductor 8, back through the jack 25, the cord conductor 30, the upper left impedance coil 28, the armature 43, the contact 40, the lead 39, the armature 38, and the contact 36, to the negative terminal of the source 26. With this direction of current flow through the armature 11 it rotates, for example, from right to left and, through the shaft 12 and the gear member 17, causes pawls 20 and 21 to move from left to right. When the armature 11 has completed one revolution, its bar member 23 now resting against the other side of the stop 24, the pawl 20 will have engaged the tooth of the ratchet wheel 19 and caused it to be advanced one step. At the end of a predetermined interval of time, for example, fifteen seconds, the clock mechanism 34 opens the circuit of relay 37 which causes the armatures 38 and 38' to break their connection with contacts 36 and 36', respectively, and to re-establish their connection with contacts 35 and 35', respectively. This changes the direction of current flow back to its original direction, which causes the armature 11 to rotate, for example, from left to right and when the armature 11 has completed one revolution, to advance the ratchet wheel as before. It is obvious that this cycle will be repeated each time the current is reversed. As stated above, the meter is adjusted to operate one revolution on minimum line current in a predetermined period of time, for example, in slightly less than fifteen seconds. In other words, under the minimum line current the armature 11 completes its rotation and advances the ratchet wheel one step shortly before each reversal of the current. Therefore, if the normal current flow through any station is below the average, the registration takes place just shortly before each reversal. On the other hand, if the normal current flow through any station is above the average, the armature quickly completes its revolution and advances the ratchet wheel, and then remains idle during the remainder of the period. Also, if during the conversation there should occur variations of current through any one substation due to central office battery voltage fluctuations, variations in transmitter resistance, or to any other cause, the time in which the armature would complete its revolution and advance

the ratchet wheel one step would be diminished, or increased, according to whether the current increased or decreased. During the connection described, the meter M' of the called subscriber is not being operated because the current in the line conductors 8₁ and 8₁' is not being reversed. When the receivers are returned to the hooks, the reversals, and hence the registration, will cease.

As shown and described, the current reversing means is connected on one side of the cord circuit only, since, in general, it is desirable to charge the call to the calling subscriber only. It is obvious, however, that the same mechanism could be applied on the other side of the cord circuit, or on both sides of the cord circuit, if desired. The current reversing means 33, indicated in the drawing below the dotted line 52-52', may be common to all of the cords of a given exchange, or to a group of cords, the connections for such common use being shown at 53, 53', 54 and 54', or, if desired, may be supplied for each cord separately. Likewise, the association of said current reversing means with the cord circuit may be under the control of other means than the relay 32 in such a manner that the operation of the meter will begin at any desired time during the connection.

While this invention has been illustrated in connection with a typical cord circuit using manual operation, it is apparent that it is equally applicable to machine switching apparatus.

What is claimed is:

1. In combination, a meter having a magnet and an armature adapted to rotate in opposite directions when currents in opposite directions are transmitted therethrough, means for preventing said armature from rotating more than one complete revolution at a time in either direction, and means for measuring the number of complete revolutions said armature rotates.
2. In combination, a meter having a magnet and an armature adapted to rotate one complete revolution in either direction in a predetermined period of time when current of predetermined value is transmitted therethrough, means for preventing said armature from rotating more than one complete revolution at a time in either direction, and means for registering the number of complete revolutions said armature makes.
3. In combination, a meter having a magnet and an armature adapted to rotate one complete revolution in either direction in a predetermined period of time when current of predetermined value is transmitted therethrough, the direction of said rotation being dependent upon the direction of current flow through said armature, means for preventing said armature from rotating more than one complete revolution at a time in either direction, and means for registering the number

of complete revolutions said armature makes.

4. In combination, a permanent magnet, a receptacle containing mercury, a pivoted disk immersed in said mercury and adapted to rotate in opposite directions when current is transmitted therethrough in opposite directions, a bar member fastened to said disk, a stop member adapted to engage said bar member when said disk has rotated one complete revolution in either direction and to prevent the further rotation of said disk at that time in that direction, and means for registering only the number of times said disk rotates a complete revolution in either direction.

5. In combination, a permanent magnet, a receptacle containing mercury, a pivoted disk immersed in said mercury and adapted to rotate one complete revolution in either direction in a predetermined period of time when current of predetermined value is transmitted therethrough, means for preventing said disk from rotating more than one complete revolution at a time in either direction, and means for registering the number of complete revolutions said disk makes in both directions.

6. In combination, a permanent magnet, a receptacle of insulating material containing mercury, a pivoted disk immersed in said mercury and adapted to rotate one complete revolution in either direction in a predetermined period of time when current of predetermined value is transmitted therethrough, the direction of said rotation being dependent upon the direction of current flow through said disk, a bar member fastened to said disk, a stop member adapted to engage said bar member when said disk has rotated one complete revolution in either direction and to prevent said disk from rotating more than one complete revolution at a time in either direction, and means for registering only the number of times said disk rotates a complete revolution in either direction.

In testimony whereof, I have signed my name to this specification this 26th day of July, 1929.

WILLIAM H. EDWARDS.

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