

COMMON SYSTEMS
ANNOUNCEMENT CIRCUIT
EMPLOYING KS-16765, LIST 1 ANNOUNCEMENT SET

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

This circuit provides facilities for magnetic recording and reproducing of audio-frequency signals in the voice range usually encountered in telephone speech.

SECTION II - DETAILED DESCRIPTION

1. GENERAL

This circuit comprises the KS-16765, List 1 announcement set and is intended to be controlled remotely from a suitable control unit, such as a modified key telephone set. For this reason, no provisions have been made for local recording or reproducing (monitoring) of speech at the set without the use of an external remote control unit.

This circuit consists of a power supply, relay control circuitry, a KS-16765, List 3 recorder, and a KS-16765, List 4 (or List 6) amplifier. The recorder contains a drive motor, magnetic recording drum and head, erase coil, control solenoids, and various switches. It embodies a variable-cycle feature which automatically adjusts the length of the cycle to reproduce only that portion of the drum which has been recorded. As normally furnished, the maximum recording time for the list 3 recorder is 2 minutes. The maximum recording time can be increased to 3 minutes for a recorder equipped with a B-650412 drive assembly by replacement of a pulley. Replacement of this pulley is described in detail in the associated Bell System Practices, Plant Series. The list 4 amplifier (included in list 1 sets with serial number 8135 and lower) is a vacuum tube amplifier which provides amplification for both recording and reproducing, an automatic volume control feature for minimizing variation in level of recorded speech, and a high-frequency oscillator to provide the bias current required for magnetic recording. This amplifier cannot be used in list 1 sets with serial number 8136 and higher. The list 6 amplifier (included in list 1 sets with serial number 8136 and higher) is a direct replacement for the list 4 amplifier and will function in all KS-16765, List 1 sets.

2. ANNOUNCEMENT RECORD - SC1

An announcement record cycle is initiated by grounding lead "D" to operate relay D.

Relay D operated:

(a) Operates relay ST.

(b) Conditions the amplifier input and output circuits and the record-reproduce head circuit for the record function. The head is connected to the amplifier record output (terminal P of J1) while the amplifier input (terminal A of J1) is connected to lead "R4". Capacitor C7 serves to isolate the amplifier input and output which are coupled through the interspring capacitance of the contact springs on relay D.

(c) Enables the bias oscillator circuit to generate the high-frequency bias current required for magnetic recording.

(d) Enables the automatic volume control feature in the amplifier by connecting terminals L and S of J1.

Relay ST operated:

- (a) Connects 48 volts ac to the motor, causing the recording drum to rotate.
- (b) Connects 48 volts dc to the filaments of the electron tubes in the list 4 amplifier.
- (c) Connects 48 volts dc to the recorder and to relays A, B, E, and STP.
- (d) Energizes erase coil L3 which erases the previously recorded announcement as the drum rotates through at least one complete revolution.

Timing of the erase cycle is controlled by the drum-operated switches S2 and S3. Since the drum is not mechanically indexed during idle periods and is allowed to coast to a stop at the end of a cycle, it is expected that the drum will be randomly oriented at the start of successive cycles of operation. Timing of the erase cycle starts with the first operation of switch S3 which operates relay A. Operation of switch S2 prior to the first operation of switch S3 causes no action.

Relay A operated:

- (a) Closes a locking path to ground.
- (b) Closes a path from relay B to switch S2.

Approximately 2 seconds after closure of switch S3, switch S2 is momentarily closed to operate relay B.

Relay B operated:

- (a) Closes a locking path to ground.
- (b) Closes in part a shunt-down path for relay A to switch S3.

After approximately 1 second, switch S3 closes to release relay A by grounding the shunt-down resistor R11.

Relay A released:

- (a) Connects ground to the winding of relay E. As switch S3 opens, ground is removed from resistor R11, and relay E is allowed to operate.

Relay E operated:

- (a) Operates solenoid L1.
- (b) Operates solenoid L2 which allows the adjustable limit switch S1 assembly to return to its start position.
- (c) Disconnects 48 volts dc from erase coil L3. The recording medium has thus been erased during a complete revolution of the drum and is ready for recording a new announcement.

- (d) Connects 48 volts dc to the amplifier.

- (e) Connects 10 volts ac to lead "DL1 (E)".

Solenoid L1 operated:

- (a) Pulls the record-reproduce head into contact with the recording medium on the drum.
- (b) Engages the half-nut and lead screw.

Application of 10 volts ac to lead "DL1 (E)" indicates the start of the actual recording cycle. Speech, which is applied to leads "T4" and "R4", is recorded on the magnetic recording band. For optimum recording characteristics, the level of speech signals at leads "T4" and "R4" should be in the range of approximately -20 vu to -30 vu. However, since an automatic volume control feature has been incorporated in the recording amplifier, satisfactory recordings will usually be obtained for levels of at least ± 10 db outside this range. Transmitter current is supplied to leads "T4" and "R4" of sufficient magnitude to result in an adequate level of speech for recording for normal speaking when using a 300- or 500-type telephone set.

The record cycle is terminated by removing ground from lead "D" to release relay D.

Relay D released:

- (a) Removes 10 volts ac from lead "DL1 (E)".
- (b) Releases relay ST.
- (c) Releases solenoid L2 which clamps the adjustable limit switch S1 assembly in position to terminate subsequent reproduce cycles at the end of the recorded announcement.
- (d) Conditions the amplifier input and output circuits and the record-reproduce head circuit for the reproduce function.

Relay ST released:

- (a) Disconnects 48 volts dc from the amplifier.
- (b) Disconnects 48 volts ac from the motor, and the recording drum coasts to a stop.
- (c) Releases solenoid L1 which disengages the half-nut and lead screw. The record-reproduce head is raised from the surface of the drum, and the carriage return spring returns the head carriage assembly to its start position.
- (d) Releases relays B and E.

This terminates a normal announcement record cycle.

If the record cycle is not terminated by removing ground from lead "D" before the maximum available recording interval has expired, switch S1 closes to operate relay STP.

Relay STP operated:

- (a) Closes a locking path to relay D.
- (b) Releases solenoid L2.
- (c) Releases solenoid L1 which allows the head carriage to return to its start position.
- (d) Releases relay ST.
- (e) Releases relay B.
- (f) Releases relay E which removes 10 volts ac from lead "DL1 (E)".

Relay ST released:

- (a) Removes 48 volts ac from the motor.
- (b) Removes 48 volts dc from the amplifier.

The drum stops, and no operation can occur until ground is removed from lead "D". Removal of ground from lead "D" releases relay D which in turn releases relay STP.

3. ANNOUNCEMENT REPRODUCE

Reproduction of the recorded announcement can be controlled in any one of three modes of operation, namely: check, automatic announcement, and automatic answer. These modes of operation vary mainly in the manner in which the start command is applied.

3.1 Check - SC2

The check function is provided for applications where it may be desirable to check the recorded announcement without transmitting it to the connecting circuit.

Grounding of lead "ANN" to operate relay ST initiates the check function.

Relay ST operated:

- (a) Connects 48 volts ac to the motor, causing the recording drum to rotate.
- (b) Connects 48 volts dc to the filaments of the electron tubes in the list 4 amplifier.
- (c) Connects 48 volts dc to the recorder and to relays A, B, E, and STP.
- (d) Connects 10 volts ac to lead "CKL".

With the motor energized and the drum rotating, switches S2 and S3 are operated momentarily, once per revolution of the drum. The first closure of switch S3 operates relay A. Operation of switch S2 prior

to the first operation of switch S3 causes no action.

Relay A operated:

- (a) Closes a locking path to ground.
- (b) Closes a path from relay B to switch S2.

Approximately 2 seconds after closure of switch S3, switch S2 is closed momentarily, to operate relay B.

Relay B operated:

- (a) Closes a locking path to ground.
- (b) Closes in part a shunt-down path for relay A to switch S3.

After approximately 1 second, switch S3 closes to release relay A by grounding the shunt-down resistor R11.

Relay A released:

- (a) Connects ground to the winding of relay E.

As switch S3 opens, ground is removed from resistor R11, and relay E is allowed to operate.

Relay E operated:

- (a) Operates solenoid L1 which pulls the record-reproduce head into contact with the recording medium on the drum while engaging the half-nut and lead screw.
- (b) Connects 48 volts dc to the amplifier.

The recorded announcement is reproduced on leads "T4" and "R4". At the end of the recorded announcement, switch S1 is closed to operate relay STP.

Relay STP operated:

- (a) Closes a locking path to ground.
- (b) Releases relays B and E.
- (c) Releases solenoid L1 which disengages the half-nut and lead screw. The record-reproduce head is raised from the surface of the drum, and the carriage return spring returns the head carriage assembly to its start position.

The drum continues to rotate and, at the next closure of switch S3, relay A is operated to release relay STP. The cycle, as described previously, is repeated continuously as long as ground remains on lead "ANN". Removal of ground from lead "ANN" during the cycle releases relay ST which, in turn, removes power from the motor, de-energizes the amplifier, and releases all relays and solenoids.

3.2 Automatic Announcement - SC3

The automatic announcement function is provided for applications where it is desired that reproduction of the recorded announcement be under control of a circuit closure and that the announce cycle be continuously repeated as long as the closure remains. This mode of operation is implemented by providing W and Z options.

The cycle of operation is initiated by ground on lead "ANN" which operates relays AA and RU.

Relay AA operated:

- (a) Grounds lead "AL" with option Y.
- (b) Grounds the winding of relay A.
- (c) Closes in part the connections to leads "T" and "R".

Relay RU operated:

- (a) Operates relay ST.
- (b) Closes in part the connection to lead "T".

Relay ST operated:

- (a) Connects 48 volts ac to the motor, causing the recording drum to rotate.
- (b) Connects 48 volts dc to the filaments of the electron tubes in the list 4 amplifier.
- (c) Connects 48 volts dc to the recorder and to relays B, E, and STP.
- (d) Operates relay A.

Relay A operated:

- (a) Closes a locking path to ground.
- (b) Closes a path from relay B to switch S2.

With the motor energized and the drum rotating, switches S2 and S3 are operated momentarily, once per revolution of the drum. The first closure of switch S2 operates relay B. Operation of switch S3 prior to the first operation of switch S2 causes no action.

Relay B operated:

- (a) Closes a locking path to ground.
- (b) Closes in part a shunt-down path for relay A to switch S3.
- (c) Removes ground from lead "AL".
- (d) Grounds lead "AL1".
- (e) Opens the operate path of relay A.

- (f) Closes leads "T" and "R" to one winding of the amplifier output transformer T2.

After approximately 1 second, switch S3 closes to release relay A by grounding the shunt-down resistor R11.

Relay A released:

- (a) Connects ground to the winding of relay E.

As switch S3 opens, ground is removed from resistor R11, and relay E is allowed to operate.

Relay E operated:

- (a) Operates solenoid L1 which pulls the record-reproduce head into contact with the recording medium on the drum while engaging the half-nut and lead screw.

- (b) Connects 48 volts dc to the amplifier.

The recorded announcement is reproduced on leads "T" and "R" at a level of approximately 0 vu. The announcement also appears on leads "T4" and "R4" and leads "MON1" and "MON2", but at a much lower level. At the end of the recorded announcement, limit switch S1 is closed to operate relay STP.

Relay STP operated:

- (a) Releases relays B and RU.
- (b) Releases solenoid L1 which disengages the half-nut and lead screw. The record-reproduce head is raised from the surface of the drum, and the carriage return spring returns the head carriage assembly to its start position. Switch S1 opens.

Relay B released:

- (a) Grounds the winding of relay A.
- (b) Removes ground from lead "AL1".
- (c) Grounds lead "AL".
- (d) Releases relay E to remove 48 volts dc from amplifier.

Relay RU released:

- (a) Opens the connection to lead "T".
- (b) Releases relay ST, which releases relay STP.

Relay STP released:

- (a) Closes 48 volts dc to relay B and to the recorder.

- (b) Operates relay RU, which operates relay ST.

Relay ST operated:

- (a) Operates relay A.

Relay A operated:

- (a) Closes a locking path to ground.
- (b) Closes a path from relay B to switch S2.

The drum continues to rotate, and the first closure of switch S2 following the operation of relay A operates relay B. Another cycle of operation is thus initiated.

The automatic announcement cycle is repeated continuously as long as ground remains on lead "ANN". If ground is removed during the cycle, relays AA and RU are released to release relay ST which releases relays B and E. Solenoid L1 releases to allow the head carriage to return to its start position. Power is removed from the motor, and all motion stops.

3.3 Automatic Answer - SC4

The automatic answer function is provided for applications where:

- (a) Only a single reproduction of the recorded announcement results for each start command.
- (b) Leads "T" and "R" are terminated in a load, such as a telephone line, which is connected to a dc voltage supply suitable for operation of relay CPC.

The circuit is prepared for automatic answer operation by grounding lead "AA" to operate relay AA.

Relay AA operated:

- (a) Closes lead "B" to one winding of relay RU with option T.
- (b) Closes leads "T" and "R" to the other winding of relay RU with option V.
- (c) Connects 10 volts ac to lead "AL".

The automatic answer reproduce cycle can be initiated by either one of two start signals, namely:

- (a) 20-cycle ringing current applied to one winding of relay RU option V;
or
- (b) Circuit closure between leads "B" and "B1" option T.

Either start signal results in the operation of relay RU. (Diode X2 provides rectification of the 20-cycle ringing current for operation of relay RU, and thermistor RT1 is provided to prevent operation of relay RU as a result of transient voltages which may be present on the telephone line.)

Relay RU operated:

- (a) Closes a locking path to ground.
- (b) Operates relay ST.

Relay ST operated:

- (a) Connects 48 volts ac to the motor, causing the recording drum to rotate.
- (b) Connects 48 volts dc to the filaments of the electron tubes in the list 4 amplifier.
- (c) Connects 48 volts dc to the recorder and to relays A, B, E, and STP.

With the motor energized and the drum rotating, switches S2 and S3 are operated momentarily, once per revolution of the drum. The first closure of switch S3 operates relay A. Operation of switch S2 prior to the first operation of switch S3 causes no action.

Relay A operated:

- (a) Closes a locking path to ground.
- (b) Closes a path from relay B to switch S2.

Approximately 2 seconds after closure of switch S3, switch S2 is closed momentarily to operate relay B.

Relay B operated:

- (a) Closes a locking path to ground.
- (b) Closes in part a shunt-down path for relay A to switch S3.
- (c) Removes 10 volts ac from lead "AL".
- (d) Connects 10 volts ac to lead "AL1".
- (e) Opens the operate path of relay A.
- (f) Closes leads "T" and "R" to one winding of the amplifier output transformer T2.
- (g) Closes leads "T" and "R" to relay CPC, and the dc voltage on leads "T" and "R" results in operation of relay CPC.

Relay CPC operated:

- (a) Provides a dc termination for leads "T" and "R" to trip ringing current when a 20-cycle ringing start signal is used.
- (b) Closes locking path to leads "T" and "R" in parallel with contact on relay A.
- (c) Closes holding path for relay RU in parallel with contact on relay E.
- (d) Closes lead "A" to lead "A1".

After approximately 1 second, switch S3 closes momentarily to release relay A by grounding the shunt-down resistor R11.

Relay A released:

- (a) Connects ground to winding of relay E.

As switch S3 opens, ground is removed from resistor R11, and relay E is allowed to operate.

Relay E operated:

- (a) Operates solenoid L1 which pulls the record-reproduce head into contact with the recording medium on the drum while engaging the half-nut and lead screw.
- (b) Connects 48 volts dc to the amplifier.

The recorded announcement is reproduced on leads "T" and "R". At the end of the recorded announcement, limit switch S1 is closed to operate relay STP.

Relay STP operated:

- (a) Closes a locking path to ground.
- (b) Releases relays B, E, and RU.
- (c) Releases solenoid L1 which disengages the half-nut and lead screw. The record-reproduce head is raised from the surface of the drum, and the carriage return spring returns the head carriage assembly to its start position.

Relay B released:

- (a) Removes 10 volts ac from lead "A11".
- (b) Connects 10 volts ac to lead "A1".
- (c) Disconnects leads "T" and "R" from winding of amplifier output transformer T2.
- (d) Disconnects leads "T" and "R" from relay CPC which causes relay CPC to release and open leads "A" and "A1".

(Leads "B" and "B1" are opened in the connecting circuit as a result of opening leads "A" and "A1".)

Relay E released:

- (a) Removes plate supply voltage from amplifier.

Relay RU released:

- (a) Releases relay ST.

Relay ST released:

- (a) Releases relay STP.
- (b) Removes filament voltage from the last 4 amplifier.
- (c) Removes 48 volts dc from relays A, B, E, and STP.
- (d) Removes 48 volts dc from solenoids in recorder.
- (e) Removes 48 volts ac from motor.

With the motor de-energized, the drum stops rotating, and the circuit is prepared to accept another start signal and to repeat the cycle of operation.

The automatic answer cycle may be stopped at any time during the cycle by:

- (a) A momentary interruption in the dc voltage on leads "T" and "R";
- or
- (b) Removal of ground from lead "AA".

Either of these two occurrences will result in the release of relay CPC. Relay CPC released releases relay RU which in turn releases relay ST, and the remainder of the relays and solenoids are subsequently released. The motor is de-energized, and all motion stops.

3.4 Line Seizure Delay Time

In some applications of the announcement set, for example, automatic telephone answering service, it is desirable that reproduction of the recorded announcement be delayed for at least some minimum interval following receipt of the start signal. For other announcement applications, however, it is desirable that this delay be as short as possible.

For the first case, a mode of operation is provided which will assure a minimum delay time of at least 2 seconds before relay CPC is connected across leads "T" and "R" to provide a dc termination; the announcement starts approximately 1 second later. Due to the fact that the recording drum is

not mechanically indexed in any particular reference position, and can therefore be assumed to be randomly oriented at the start of successive announcement cycles, an uncertainty exists in line seizure delay time of one revolution of the drum, or approximately 3 seconds. Thus, the line seizure delay time for this mode of operation for successive cycles may vary from 2 seconds minimum to 5 seconds maximum, with the announcement following approximately 1 second later in any case. This mode of operation is described for automatic answer in 3.3.

For minimum line seizure delay time, option Z is required. When this option is provided, the line seizure delay time for successive cycles may vary from 0 to 3 seconds maximum. The operation of the circuit differs from that described for automatic answer (see 3.3) only in that relay A is operated by relay ST, and the closure of switch S2 operates relay B. The line seizure delay time is thus reduced by an amount equal to the time interval between the operation of switches S3 and S2, or 2 seconds.

4. RECORD-REPRODUCE AMPLIFIER

A KS-16765, List 4 amplifier is included as a part of announcement sets bearing serial number 8135 and lower. It cannot be used as a replacement amplifier in sets bearing serial numbers higher than 8135. This amplifier is of printed wiring board construction and provides amplification for both recording and reproducing, an automatic volume control feature for minimizing variation in level of the recorded speech, and a high-frequency oscillator to provide the bias current required for magnetic recording.

The first two stages of the amplifier, electron tubes V1 and V2, provide voltage amplification with resistance-capacitance coupling between the stages. Power amplification is provided by the output stage, electron tube V3. During the recording function, the bias oscillator composed of electron tube V4 and associated components is enabled. During recording, the automatic volume control feature is also enabled and limits the average speech level output of the amplifier to a much smaller variation than the input. This volume limiting feature operates on the average level of the speech to adjust the gain of the amplifier to limit extreme variation in output level, but the actual speech signals themselves are unaffected.

The volume limiting feature is obtained as follows. During recording, terminal S of J1 (output of the amplifier) is connected to terminal L. A small portion of the speech signal voltage appearing at the output of the amplifier is thus applied to diode X1 for rectification. This diode is connected in

the proper polarity to cause an increasing dc negative voltage across filter capacitor C14 for an increasing signal voltage level at the output of the amplifier. The control grids of the electron tubes in the voltage amplification stages are connected to capacitor C14; the first stage through resistor R1 and the second stage through a voltage divider consisting of R22 and R23. The grid-to-cathode voltage of these two stages is varied with the dc voltage output from the AVC rectifier resulting in a decrease in gain with an increase in negative voltage across capacitor C14. Thus, operating in the compression region, an increase in input level to the amplifier results in only a small increase in output level.

During the recording function, the output of the amplifier is connected to current-limiting resistor R14 and subsequently to the secondary winding of transformer T1. The speech currents are then mixed with the high-frequency (approximately 15 kc) bias current and fed to the magnetic recording head through current-limiting resistor R16. Capacitors C8 and C11, together with resistor R14, provide a filtering action to prevent the bias frequency from causing undesirable interference at the amplifier output stage V3.

A KS-16765, List 6 amplifier is included as a part of KS-16765, List 1 announcement sets with serial numbers higher than 8135, and may be used as a replacement amplifier in all KS-16765, List 1 and List 2.

This amplifier is of printed wiring board construction and provides amplification for both recording and reproducing, an automatic volume control feature for minimizing variations in level of recorded speech, and a high-frequency oscillator to provide the bias current required for magnetic recording.

A three-stage transistor amplifier provides the voltage amplification for driving the recording head and reproducing the recording on the telephone line. During the recording function the bias oscillator and the automatic volume control feature are enabled.

The automatic volume control feature limits the average speech level at the output of the amplifier to a much smaller variation than the input. It is obtained by connecting terminal S of J1 (output of the last stage) to terminal L of J1 (input to Q602, the AVC transistor). Transistor Q602 is a zero biased emitter follower which is used as a rectifier. Signal current from the output of the amplifier is fed into the base of Q602 and rectified. The rectified current flows through CR601, R606, and CR602 to ground causing the resistance of diodes CR601 and CR602 to vary inversely with the level of the output signal. These shunt diodes and their associated resistors form

a two-stage variable attenuator (vario-losser) which limits the average output speech level.

During the recording function the output from the amplifier passes through current limiting resistor R621, mixes with the high-frequency bias current, and is applied to the magnetic recording head. Capacitor C612 and C616, together with resistor R627, provide a filtering action to prevent the high-frequency bias from causing undesirable interference at the amplifier output stage.

5. POWER SUPPLY

The power supply provides three voltage sources for operation of the announcement set. These are:

- (a) 48 volts dc for operation of relays and solenoids and to provide filament current and amplifier plate supply voltage.
- (b) 48 volts ac for operation of the recorder drive motor.
- (c) 10 volts ac for lighting lamps in some applications where a key telephone set is used for local control of the announcement set.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

None.

2. FUNCTIONAL DESIGNATIONS

The functional meaning of apparatus designations used in this circuit are:

<u>Apparatus Designation</u>	<u>Functional Meaning</u>
AA	Automatic Answer
CPC	Calling Party Control

<u>Apparatus Designation</u>	<u>Functional Meaning</u>
D	Dictate
RU	Ring Up
ST	Start
STP	Stop

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Designations not included in the above list are reference designations and have no functional meaning.

3. FUNCTIONS

The functions of this circuit are to:

- (a) Magnetically record speech, applied to leads "T1" and "R1", up to a maximum capacity of 2 minutes.
- (b) Reproduce recorded announcements at leads "T" and "R" in response to either 20-cycle ringing current start signal or circuit closure start signal.
- (c) Provide variable-cycle feature which automatically adjusts the reproduce cycle to the length of the recorded announcement.
- (d) Provide 48-volt dc and 10-volt ac power for use in a connecting circuit.

4. CONNECTING CIRCUITS

When this circuit is listed on a key-sheet, the connecting information thereon is to be followed. The following is a typical connecting circuit:

- (a) Control Station Circuit - SD-69385-01.

SECTION IV - REASONS FOR REISSUE

B. CHANGES IN APPARATUS

- B.1 L4 amplifier has been replaced by L6.
- B.2 For L3 recorder (FS3, APP, Fig. 2) KS-15914, L2 motor has been replaced by B-650412, drive assembly.
- B.3 Capacitor C3A, C3B, C3C, C2 and C14, and resistors R2, R3, R10, and R15 have been designated M wiring.

D. DESCRIPTION OF CHANGES

- D.1 L wiring has been designated as Standard and M wiring as Mfr Disc.

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EMPLOYING KS-16765, LIST 1 ANNOUNCEMENT SET

CHANGES

B. Changes in Apparatus

B.1 ADDED

C15 Capacitor

D. Description of Changes

D.1 In FS1 (Sheet B1), capacitor C15 has been added as a K option.

D.2 Circuit Note 108 has been added to provide the serial No. of sets when C15 capacitor was introduced in the manufacture of announcement sets.

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