POST OFFICE TELECOMMUNICATIONS HEADQUARTERS

DIAGRAM NOTES AT 5406A

SPECIFICATION T 9167

UAX NO. 13 MOTOR START, TIME PULSE, ALARMS AND MISC. EQUIPMENT

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1. GENERAL

This diagram shows the connexions and circuit arrangement of the motor start, time pulse, alarms and miscellaneous equipment used at a UAX No. 13 equipped with a Machine Pulsing and Ringing No. 1.

The diagram, in conjunction with AT 5445, supersedes AT 3724 for new work.

The following (or equivalent) diagrams should be considered in conjunction with this diagram:-

AT 5445	MACHINE PULSING AND RINGING NO. 1
AT 3721	UAX NO. 13 SUBSCRIBER'S LINE, LINEFINDER AND CONTROL RELAY SET.
AT 3722	UAX NO. 13 GROUP SELECTOR.
AT 4082	UAX NO. 13 MISCELLANEOUS CIRCUITS.
AT 4906	UAX NO. 13 INCOMING JUNCTION FROM PARENT OR NON-DEPENDENT EXCHANGE.
AT 4907	UAX NO. 13 OUTGOING JUNCTION PARENT EXCHANGE AND NON-PARENT MANUAL EXCHANGE TRAFFIC.
AT 5279	UAX NO. 13 FINAL SELECTOR 2-10 TYPE.
P/DC 3/1	POWER PLANT NO. 201.
P/DC 16/1	POWER PLANT NO. 204.
P/DC 37/4	POWER PLANT NO. 203 22V, 24V, 40V AND 50V.

2. FACILITY SCHEDULE

Provision is made for:-

2.1 Extending a motor start earth to complete the motor circuit of the associated pulsing and ringing machine, either

2.1.1 for continuous running, or

2.1.2 for intermittent running (start-stop working) under the control of signals received on the ringer start lead from the exchange switching equipment.

2.2 Ensuring that when the associated machine is started under condition 2.1.2, it continues running for approximately 1 minute.

2.3 Extending pulse signals, controlled by the machine, to the time pulse circuits of selectors and junction relay sets to cater for delayed forced release:-

2.3.1 A low resistance battery pulse on the start wire to indicate commencement of the timed period of 1 minute.

2.3.2 An earth pulse on the release wire at the end of the timed period to effect forced release.

2.4 Routine testing of subscribers meters in conjunction with connecting and control equipment on the appropriate A unit.

2.5 Extending and distributing, via guard relays, NU tone generated by the associated machine whenever an unobtainable multiple number is dialled, and busying the multiple number under certain fault conditions (see 2.6.4).

2.6 Connecting NU tone to the exchange fault test number circuit (multiple number 299) under any of the following fault conditions:-

2.6.1 Any alarm-type fuse in the exchange blown.

2.6.2 An a.c. power failure.

2.6.3 Any selector or regenerator in the exchange failed to release.

2.6.4 A cable pressure alarm.

2.6.5 A Meter Switching Failure.

2.6.6 The exchange battery discharged by 30% of its capacity, when working on the single battery automatic system, or power plant failure before the completion of the charge of the standby battery, when working on the charge-discharge system.

2.6.7 Positive battery low volts.

2.6.8 A connection to a distribution circuit of NU tone for unobtainable numbers is faulty in such a way that false metering would occur - i.e. an NU tone guard relay operated.

2.6.9 The meter routine test circuit left connected to a subscriber's line.

2.7 Connecting inverted ring tone to the exchange fault test number circuit when none of the faults under 2.6 exist.

2.8 Extending an earth signal to prepare the appropriate alarm lamp circuit in the associated miscellaneous equipment under any of the following fault conditions:-

2.8.1 Any alarm-type fuse in a C unit blown.

2.8.2 Failure of power plant as in 2.6.6.

2.8.3 An NU tone guard relay operated as in 2.6.8.

2.8.4 The ringer on/off switch left in the off position.

CIRCUIT DESCRIPTION

3.1 Location

It should be imagined that the diagram is divided into four equal sections which will be referred to as follows:-

Left (L) Centre left (CL) Centre right (CR) Right (R). Each relay coil and relay contact is immediately followed by an indication of its location in an abbreviated form as shown in the brackets above.

3.2 Outline

The equipment consists of two relay sets, corresponding to Figs. 1 and 2, and a rack-mounted 11-step relay (Fig. 3). Fig. 1 is fitted in Unit C1 on the basis of one per UAX and incorporates the motor start, fault test number, and (with Fig. 3) the meter test circuits; the relays providing power plant, release and fuse alarms; and arrangements for repeating pulses to the time pulse circuits (Fig. 2). Fig. 2 is fitted on the basis of one per C unit (i.e. per exchange section of equipment for 200 subscribers) and incorporates time pulse release control, fuse alarm and NU tone guard circuits.

When continuous running of the associated machine is required, the ringer start lead is permanently earthed at the U-points and the hold circuit of relay MS and the operate circuit of relay LR is disconnected to eliminate unnecessary wear and current drain.

For start-stop working, the operation of relay MS is controlled by signals from (a) the exchange equipment via the ringer start or the time pulse start leads or (b) the fault test number or meter routine test circuits. On reception of a start signal, relay MS is held over its auxiliary winding for a period of at least 1 minute until the operation of relay RC to the Z pulse from the machine. Unnecessary wear on the machine due to fleeting start signals is thus reduced. The 1 minute S and Z pulses from the machine which are used to control the hold of relay MS for a minimum period are also repeated to the time circuits by relays PS and PZ. A maximum of four repetition phases are provided to cater for up to four relay sets to Fig. 2 in an 800 line UAX.

The fault test number circuit provides a distant operator or exchange staff with a means of ascertaining whether certain faults exist; the meter routine test circuit employs an 11-step relay to provide trains of 10 pulses, obtained from a source of continuous pulses on the machine, for testing subscriber's meters; the time pulse circuit uses pulses repeated from the 1 minute S and Z supplies to control the application of forced release conditions; and the NU tone guard relays (NUA etc.) operating to any fault condition which would operate final selector D relays, provide for early removal of possibilities of over-registration.

3.3 Detail

The following operational details are described in subsequent paragraphs:-

3.3.1 Motor start controls.

3.3.1.1 Continuous running.
3.3.1.2 Start-stop working.

3.3.2 Time pulse controls.

3.3.3 Meter routine test circuit.

3.3.4 N.U. tone for unobtainable numbers.

3.3.5 Fault conditions.

3.3.5.1 Line faults on unobtainable numbers.
3.3.5.2 Fuse and a.c. fail alarms.
3.3.5.3 Ringer on/off switch alarm.
3.3.5.4 Meter routine test circuit left connected to a subscriber's line.
3.3.5.5 Charge failure alarm.
3.3.5.6 Release, Cable pressure, Meter Switching fail and positive battery low voltage alarms.

3.3.6 Fault test number circuit.

3.3.1 Motor start controls

The motor start circuit provides the associated ringing and pulsing machine with either continuous running conditions (see Note 3 on the diagram) or start-stop working under the control of signals from the exchange equipment.

3.3.1.1 Continuous running

For continuous running, shelf jack U-points 11 and 20 (Fig. 1) are strapped and relay MS is permanently operated to the earth on U11.

Relay MS	(L)	operating,
MS1	(L)	is ineffective.
MS2	(L)	operates relay MSA.
MS3	(L))	connect relays PS and PZ to the 1 minute S and Z pulse
MS4	(L))	leads respectively.
Relay MSA	(L)	operating,
MSA1	(L)	extends earth on the motor start lead to complete the motor armature circuit of the ringer.

3.3.1.2 Start-stop working

Normally, an earth signal is received from the exchange switching equipment on the ringer start lead to operate relay MS when the machine services are required. In addition, relay MS may be held operated by the time pulse, meter test or fault test number circuits. See pars. 3.3.2, 3.3.3 and 3.3.6.

Relay MS	(L)	operating,
MS1	(L)	holds relay MS dependent on contact RC1.
MS2	(L)	operates relay MSA.
MS3	(L)	prepares to operate relay PS to the 1 minute S pulse.
MS4	(L)	prepares to operate relay PZ to the 1 minute Z pulse.
Relay MSA	(L)	operating,
MSA1	(L)	extends earth on the motor start lead to complete the motor armature circuit of the ringer.

The machine having started, 1 minute S and Z pulses will be applied to the appropriate leads. Should a Z pulse be applied before an S pulse, relay PZ will operate, but its contacts will be ineffective, and at the end of the Z pulse, relay PZ will release, before the subsequent S pulse is received. When the first S pulse is received, relay PS operates.

Relay PS	(L)	operating,
PS1	(L)	operates relay LR.
PS2	(CL)	extend low resistance battery conditions to the time pulse start leads. See par. 3.3.2.
PS3	(CL)	
PS4	(CL)	
PS5	(CL)	

Relay LR	(L)	operating,
LR1	(L)	holds relay LR.
LR2	(L)	is ineffective at this stage.

At the end of the S pulse, relay PS releases.

Relay PS	(L)	releasing, its contacts are ineffective at this stage.

In approximately 1 minute, the subsequent Z pulse is received and relay PZ operates.

Relay PZ	(L)	operating,
PZ1	(L)	releases relay LR and operates relay RC.
PZ2	(CL)	extend earth conditions to the time pulse release leads. See par. 3.3.2.
PZ3	(CL)	
PZ4	(CL)	
PZ5	(CL)	

Relay RC	(L)	operating,
RC1	(L)	disconnects the hold circuit of the auxiliary winding of relay MS.

Assuming that relay MS is no longer held by a start signal on its main winding, relay MS releases.

Relay MS	(L)	releasing,
MS1	(L)	are ineffective at this stage.
MS3	(L)	
MS4	(L)	
MS2	(L)	releases relay MSA.

Relay MSA	(L)	releasing,
MSA1	(L)	disconnects earth from the motor circuit to stop the machine.

Relay LR	(L)	releasing, after its slow-release period,
LR1	(L)	releases relay RC.
LR2	(L)	releases relay PZ.

Relay PZ	(L)	releasing, its contacts are ineffective at this stage.

Relay RC	(L)	releasing, its contact is ineffective at this stage.

Should the machine services be still required after the minimum running period, when contact RC1 (see above) disconnects the auxiliary hold winding of relay MS, the relay remains held to the start signal on the main winding and relay MSA remains operated.

Relay LR	(L)	releasing, after its slow-release period,
LR1	(L)	releases relay RC.
LR2	(L)	is ineffective at this stage.

Relay RC	(L)	releasing,
RC1	(L)	holds relay MS over its auxiliary winding.

At the end of the Z pulse, relay PZ releases.

Relay PZ (L) releasing, its contacts are ineffective at this stage.

The machine continues running, and the sequence of operations of relays PS, LR, PZ and RC continues with subsequent S and Z pulses while the start condition continues on the main winding of relay MS. When the start signal is finally removed, the next Z pulse causes the machine to stop due to the operation of contact RC1, and relays MS, MSA, LR, PZ and RC release as described above.

3.3.2 Time pulse controls

Delayed forced release of circuits is controlled by the TP relay circuit in conjunction with the 1 minute S and Z pulses. Selectors or junction equipment under conditions requiring delayed forced release (PG, CSH etc.) will receive a release signal after a period of approximately 1 to 2 minutes. To initiate the time pulse release, a start earth is received from the time pulse circuit of the exchange equipment concerned, via its TM (or equivalent) relay, to operate relay TP over its high resistance winding.

Relay TP	(CR)	operating,
TP1	(CR)	extends earth to operate or hold relay MS, and circuit operations as described in par. 3.3.1.2 continue.

Relay PS	(L)	operating to an S pulse,
PS1	(L)	operates relay LR. See par. 3.3.1.2.
PS2	(CL)	connects the two windings of relay TP in parallel to return a low resistance battery condition on the start wire, whilst maintaining the hold of relay TP.
PS3	(CL))	perform similar functions to contact PS2 for equipment in the 2nd, 3rd and 4th sections of the exchange
PS4	(CL))	
PS5	(CL))	

The increased current due to the operation of contact PS2, causes the operation of relay TM (or equivalent) in the exchange selector or junction relay set, and that relay then holds over the hold lead to resistance R1 in parallel with the low resistance winding of relay TP, and prepares its circuit for the reception of the subsequent release signal.

Relay PS (L) releasing, at the end of the S pulse, its contacts are ineffective at this stage.

After a period of approximately 1 minute, the Z pulse operates relay PZ.

Relay PZ	(L)	
PZ1	(L)	releases relay LR and operates relay RC. See par. 3.3.1.2.
PZ2	(CL)	extends earth on the release lead to effect the forced release required.
PZ3	(CL))	perform similar functions to contact PZ2 for equipment in the 2nd, 3rd and 4th sections of the exchange.
PZ4	(CL))	
PZ5	(CL))	

On release of the selector or junction relay set, the holding earth is disconnected from the hold lead of relay TP, and, if no other associated equipment is in the process of time pulse release, relay TP releases.

Relay TP	(CR)	releasing,
TP1	(CR)	disconnects the holding earth from the main winding of relay MS.

3.3.3 Meter routine test circuit

For meter routine testing, the subscriber's line equipment is connected, via control equipment on the appropriate A unit, to the meter

test circuit by means of a cord and clip. If the subscriber's line is free, relay K in the line circuit and relay T in this circuit operate in series.

Relay T	(CL)	operating,
T1	(CL)	disconnects inverted ring tone and connects NU tone to the fault test number circuit, to provide an alarm condition should the meter test circuit be left connected to a subscriber's line circuit.
T2	(CL)	completes the circuit for the meter test lamp on the A unit, and removes earth from the control keys on the A unit.
T3	(CL)	operates relay MS to cater for the generation of meter test pulses by the machine.
T4	(CL)	prepares the circuit for the eleven step relay MRT.

When the "Non-operate" control key on the A unit is thrown, the circuit is completed for the eleven step relay. When the relay steps off-normal, the earth from the key via contact T4 is extended to relay ST which operates during the off period between two battery meter test pulses.

Relay ST	(CL)	operating,
ST1	(CL)	extends meter test pulses to the meter being tested via relay A which pulses.

Relay A	(CL)	pulsing,
A1	(CL)	disconnects the circuit of the meter test lamp on the A unit.
A2	(CL)	pulses the 11-step relay.

The stepping continues until, after 10 pulses have been sent, the 11-step relay springs break again and relay ST releases.

Relay ST	(CL)	releasing,
ST1	(CL)	prevents further pulses being extended to the subscriber's meter, and relay A.

The same circuit operations occur subsequently when the "Operate" control key on the A unit is thrown. In this case, however, the subscriber's meter should operate ten times to the 10 meter test pulses sent.

3.3.4 N.U. tone for unobtainable numbers

All lines unallotted, ceased, temporarily out of service or faulty are connected to one of the relays NUA, NUB, NUC or NUD. Should one of these lines be dialled, relay P operates to the earth extended by relay H in the final selector, and battery from the NUA (or equivalent) relay winding on the negative line trips the ringing.

Relay P	(R)	operating,
P1	(CR)	connects N.U. tone to the 570 ohm windings of relays NUA etc.

3.3.5 Fault conditions

3.3.5.1 Faults on unobtainable numbers

Should an exchange fault develop on the negative or positive wires which are connected to the NUA etc. relays (e.g. earth on the negative or battery on the positive) false metering due to the operation of both relays F and D in the final selector on switching to the

N.U. tone circuit, is prevented by the operation of relay NUA (or equivalent) busying the multiple. This is considered an alarm condition and the operation of the guard relay NUA (or equivalent) completes the alarm circuit. Assume that a faulty line is associated with relay NUA, which operates.

Relay NUA	(CR)	operating,
NUA1	(CR)	operates relay P and earths the P wire to prevent a final selector switching in.
NUA2	(CR)	prepares the N.U. tone alarm lamp circuit, which is completed by a press button in the lamp display equipment.
NUA3	(CR)	operates relay FA in order to extend the alarm to the fault test number circuit. See par. 3.3.5.2.

3.3.5.2 Fuse and a.c. failure alarms

Any fuse blowing causes relay FA to operate either directly or indirectly as described below. Relay FA is also operated directly by the N.U. tone guard relays as described in par. 3.3.5.1 or by an a.c. failure, and indirectly by the ringer on/off switch as described in par. 3.3.5.3. Should the fuse of any positive battery circuit blow, the alarm spring and alarm bar make contact and relay PA operates. Should the positive battery alarm fuse blow, relay PA operates with its non-inductive winding in series with its operate winding.

Relay PA	(CR)	operating,
PA1	(CR)	operates relay MA.

Relay MA	(CR)	operating,
MA1	(CR)	operates relay FA.
MA2	(CR)	prepares the fuse alarm lamp circuit, which is completed by a press-button in the lamp display equipment.

Relay FA	(L)	operating,
FA1	(CL)	disconnects inverted ring tone and connects N.U. tone to the fault test number circuit.

Should a negative battery fuse in a C unit, or its associated alarm fuse blow, relay MA is operated over its earth connected winding or over both windings in series respectively.

Relay MA	(CR)	operating,
MA1	(CR)	operates relay FA.
MA2	(CR)	prepares the fuse alarm lamp circuit, which is completed by a press-button in the lamp display equipment.

Relay FA	(L)	operating,
FA1	(CL)	disconnects inverted ring tone and connects N.U. tone to the fault test number circuit.

Should a negative battery fuse in an A or B unit, or the associated alarm fuse blow, the FA relay on the unit concerned is operated, and a contact of this relay extends earth on the fuse alarm lead to operate relay FA in this circuit.

Relay FA	(L)	operating,
FA1	(CL)	disconnects inverted ring tone and connects N.U. tone to the fault test number circuit.

Should there be a failure of the a.c. supply, earth is extended on the a.c. fail and fuse alarms lead to operate relay FA.

Relay FA (L) operating,
FA1 (CL) disconnects inverted ring tone and connects N.U. tone to the fault test number circuit.

3.3.5.3 Ringer on/off switch alarm

Should the Machine Pulsing and Ringing No. 1 be placed in position with its manually operated on/off switch in the off position, the machine will not respond to a start signal. Arrangements are made, therefore, that when the switch is in the off position, an earth is extended, when the machine is jacked-in to operate relay MA.

Relay MA (CR) operating,
MA1 (CR) operates relay FA.
MA2 (CR) prepares to light the fuse alarm lamp of the C1 unit.

Relay FA (L) operating,
FA1 (CL) is ineffective at this stage as no tones are being generated.

3.3.5.4 Meter routine test circuit left connected to a subscriber's line

This condition is covered in par. 3.3.3.

3.3.5.5 Charge failure alarm

Should the charging current fail or the exchange battery discharge by 30% of its capacity, a circuit is completed to operate relay CF.

Relay CF (L) operating,
CF1 (L) prepares the charge fail lamp circuit, which is completed by a press-button in the lamp display equipment.
CF2 (L) disconnects inverted ring tone and connects N.U. tone to the fault test number circuit.

3.3.5.6 Release Cable Pressure, positive battery and Meter Switching Fail alarm

Should any selector or regenerator in the exchange fail to release, the RA relay in the unit concerned remains operated, and a contact of this relay extends earth on the release alarm lead to operate relay RA in this circuit.

Should there be a Cable Pressure alarm, positive battery alarm, or Meter Switching failure, earth is also extended to operate relay RA in this circuit.

Relay RA (L) operated,
RA1 (L) disconnects inverted ring tone and prepares to connect N.U. tone to the fault test number circuit. See contact TN3 under par. 3.3.6.
RA2 (CL) disconnects the circuit of relay RB.

3.3.6 Fault test number circuit

As the UAX is normally unattended, provision is made by means of this circuit, for distant staff, by dialling the UAX multiple number 299, to establish whether a major fault exists. Reception of N.U. tone indicates

that a fault exists while inverted ring tone is returned under "no fault" conditions.

When the final selector switches to the fault test number circuit relay TN operates to the earth condition extended on the P wire, and the ringing is tripped by the retard TT.

Relay TN	(CL)	operating,
TN1	(L)	holds relay MS to cater for the generation of the required tones.
TN2	(L)	connects the appropriate tone to retard TT for transmission to the caller.
TN3	(L)	prepares to connect N.U. tone when release alarm conditions exist.
TL4	(CL)	operates relay RB when release alarm conditions do not exist.

Assuming relay RB operates (see contact TN4 above).

Relay RB	(CL)	operating,
RB1	(L)	prevents N.U. tone being returned to the caller and continues to return inverted ring tone, in the event of a subsequent operation of relay RA, for a period equivalent to the mechanical release time of a selector. See relay RB in "Design details".

Should a selector or regenerator release while the caller is connected to the fault test number circuit, relay RA will operate during the release period and then release again. If this action occurs within the release period of relay RB, no fault condition will be returned. Should the selector or regenerator fail to release, however, relay RA will remain operated.

Relay RA	(L)	operating,
RA1	(L)	is ineffective at this stage.
RA2	(CL)	releases relay RB.

Relay RB	(CL)	releasing,
RB1	(L)	disconnects inverted ring tone and connects N.U. tone to retard TT for transmission to the caller.

Should a positive battery low voltage condition, a cable pressure alarm or Meter Switching circuit fail an earth will be connected to operate relay RA.

Relay RA	(L)	operating,
RA1	(L)	connects N.U. tone to the test number circuit.

4. DESIGN DETAILS

4.1 The following relays were made slow to release for the reasons given below:

Relay LR	(L)	to ensure the operation of relay RC for a sufficient period of time, following the operation of relay PZ, to allow relays MS and MSA to release when no start signal exists on the main winding of relay MS to prolong the running of the machine.
Relay RB	(CL)	to hold for a sufficient period of time to cover the normal rectangular release time of a selector. This feature prevents, as far as possible, the unwanted application of N.U. tone to a fault test number call whenever a switch releases.

4.2 Special features are provided as follows:-

Relay PA (CR) has a high resistance of 12,000 ohms to reduce the drain on the positive battery when a distribution fuse blows.

Resistors, non-linear RX1, RX2, RX3 and RX4 are provided for spark quenching.

Contact RA1 (L) has been made a K-action to prevent mutilation of the inverted ring tone signal returned on a fault test number call whenever a switch releases.

5. HISTORY

Issue A Relays PS and PZ changed and note 5 added to cater for a fourth C unit Editorial changes and minor corrections.

Issue 1

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END OF DIAGRAM NOTES