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Proposed modifications to beam transport magnet power supplies to prevent damage resulting from power dips

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EP&S DIVISION TECHNICAL NOTE

No. 56

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PROPOSED MODIFICATIONS TO BEAM TRANSPORT MAGNET POWER SUPPLIES TO PREVENT DAMAGE RESULTING FROM POWER DIPS

There have been several incidents resulting in costly damage to beam transport magnets and/or their power supplies. In addition to the expense of repair or replacement of the damaged components, there has been the resultant loss of experimental time. In one instance where a burning magnet was adjacent to a filled hydrogen chamber we were fortunate that personnel injury and greater damage did not result.

The most frequent cause of these incidents has been the case of the saturable reactor-controlled power supply with a motor-operated molded case circuit breaker in use as the main line contactor. The undervoltage release of the breaker is used as the device by which the line circuit is opened by "OFF" buttons or protective device interlocks.

Hazards exist and damage is incurred when the power supply loses its cooling air and/or the magnet loses its cooling water but the main circuit breaker does not shut off the power supply. One or more of the following circumstances can occur in many of our older power supplies:

1. Most of the contactors and relays used for control and protection drop out in the 90-100V ac range; but the undervoltage release of the main breaker is factory set to drop out in the 48-72V ac range, and we have found some that do not operate until much lower. Obviously a line power dip resulting in a dip of the control voltage into the 80-volt range will take out some devices but not the main breaker.

2. The UV release can "hang up" when completely de-energized, such as would occur with an open series interlock circuit caused by the loss of magnet water, loss of power supply air flow, over-temperatures, etc.

3. The Sel-Rex power supply providing the control power for the magnetic amplifiers is connected to the load side of a contactor that may drop out on undervoltage. Since the mag-amps are biased "ON", loss of the control power drives the output voltage to the maximum for the particular transformer tap connected, and the resultant current will be the maximum determined by that voltage and the connected load. On most of this type power supply, the blower motors are connected to the same or a parallel contactor. Opening of this contactor(s), therefore, will cause the power supply to lose its cooling air at the same time it is running to the top output of the tap setting. The power dip may also have caused loss of the pumps providing cooling water to the magnets.

Use of a shunt trip has been recommended as the "normal" trip device but this modification to all of our molded case circuit breakers would be costly in both components and labor. Also, the shunt trip operates by energizing the device whereas the UV release functions on de-energizing. The use of a shunt trip, therefore, is not a substitute for the protection required from the UV release, but its use may be worthwhile to reduce wear on the release.

Modifications have been accomplished on one power supply (PS 431) for evaluation and possible incorporation into all units possessing the described potential for failure. This scheme was chosen because (1) it is relatively inexpensive compared to alternate schemes of adding line contactors, etc., and (2) most of the work can be prefabricated on a component board (Sketch 4) requiring only a few hours for actual installation into the power supply.

The relay components of the modification are arbitrarily prefixed KR- on the sketches to differentiate them from the control relay nomenclature (K-,96-,CR-, etc.) of the various power supply manufacturers. The intent of the modification is to perform the following new functions:

1. Sense an undervoltage situation (See Sketch 2) and drive the main circuit breaker (52) open by its motor-operator. Tests show the operator will function even at 50V ac. The UV sensor is adjustable but presently set to operate below 95V ac on the 115V ac line.

2. Prevent reclosure of the breaker until proper voltage is restored.

3. Detect the failure of the UV release to operate when the "OFF" button or the standard interlock series is opened; and after a time delay, open the circuit to the UV sensor which will drive the breaker open by means of the motor-operator.

4. Lock out the "ON" circuit and annunciate the UV release fault necessitating investigation and repair by the EAO Watch. The circuits can be reset locally at the power supply only.

5. Automatically restart the blowers in the event that the blower motor contactor is the only device to drop out on a sharp dip. If the air flow loss is too brief to open the interlock, the trip circuits will not operate. This function is also a backup scheme for providing cooling air to the power supply components in the event the main breaker still hangs up despite the redundant trip circuits. This will protect the power supply but not the magnet if the latter has lost its water.

6. Provide a time delay (See Sketch 3) of approximately 400 msec. (24 cycles) to prevent the lock-out and annunciate circuits from being activated during normal "OFF" functions.

The components used in the modifications are BNL stock items (except one relay) and cost approximately $70.00 per power supply. The component board can be fabricated in 2 man-days (possibly contracted out) and installed in an average of 1-man-day.

As stated above this modification is not the only solution to the problem, and perhaps not the best. It is presented as an inexpensive scheme whereby most of the work can be performed without requiring power supply downtime. Whereas we have over 125 mag-amp power supplies with a molded case main circuit breakers the material and manpower costs are significant factors.

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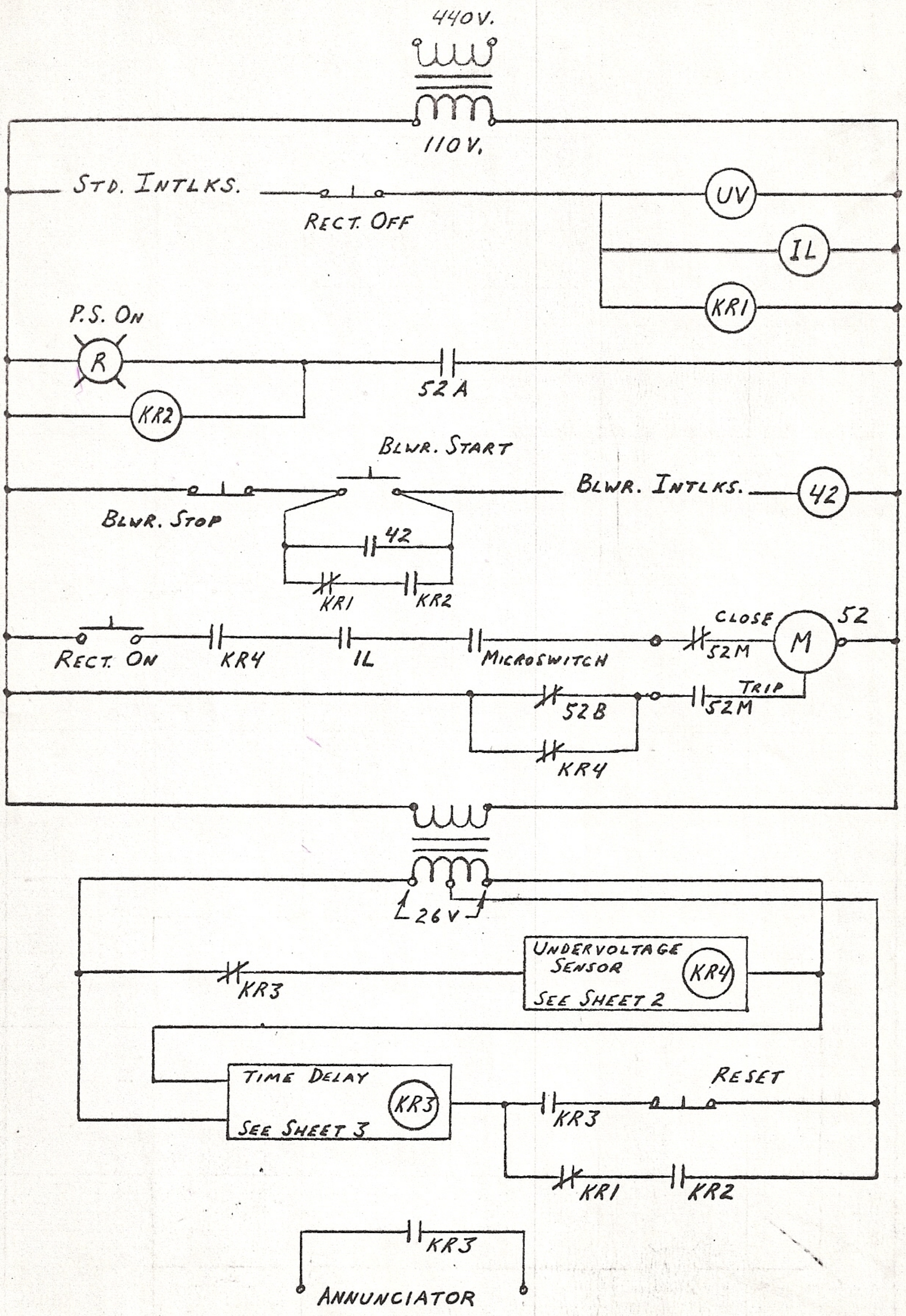
BY F.J.T., F.T. DATE 11-7-72 SUBJECT Power Supply Control with Modified Undervoltage Protection SHEET NO. 1 OF 4

CHKD. BY ________ DATE ________ JOB NO. ________

DEPT. OR PROJECT ________



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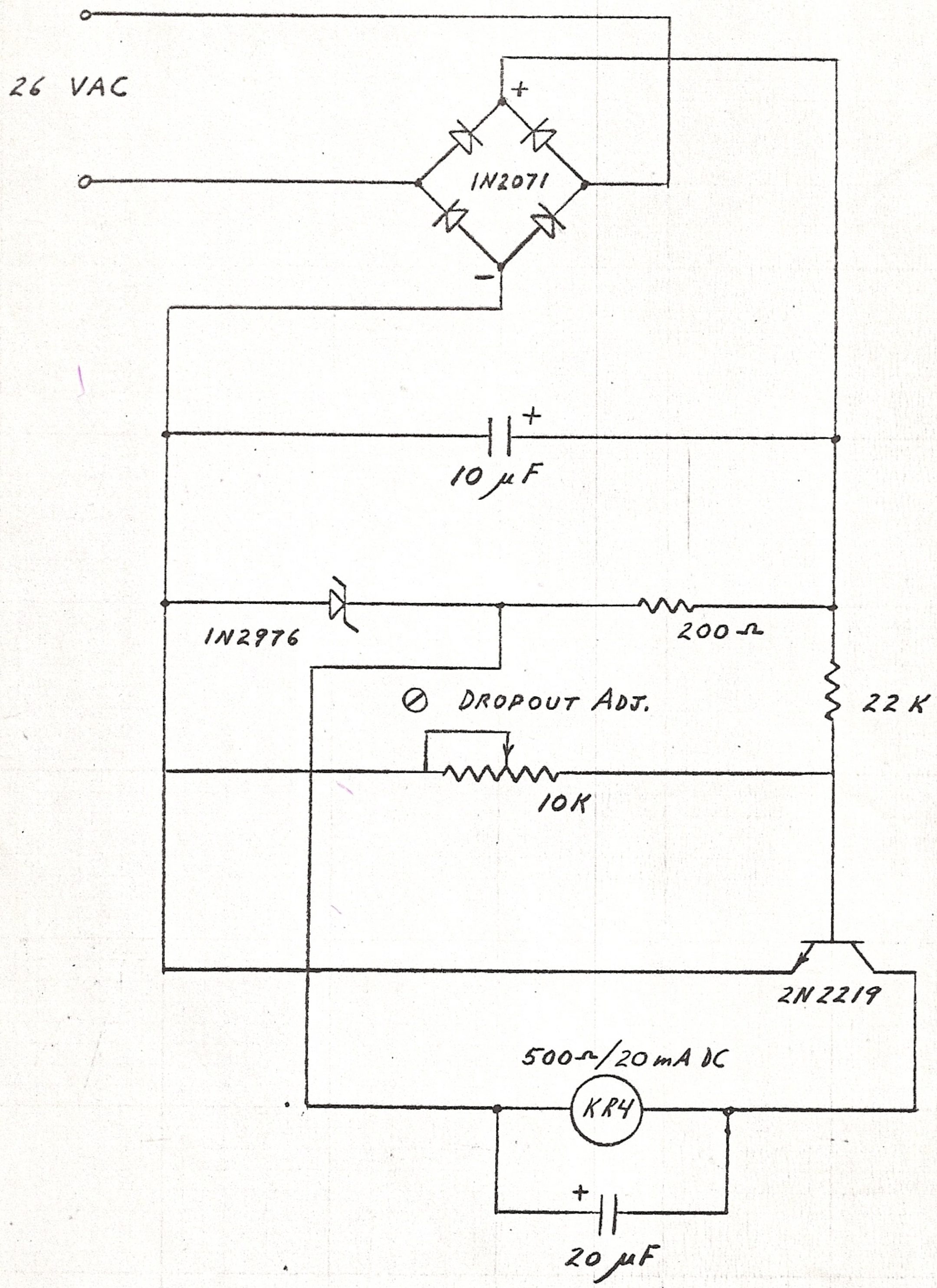

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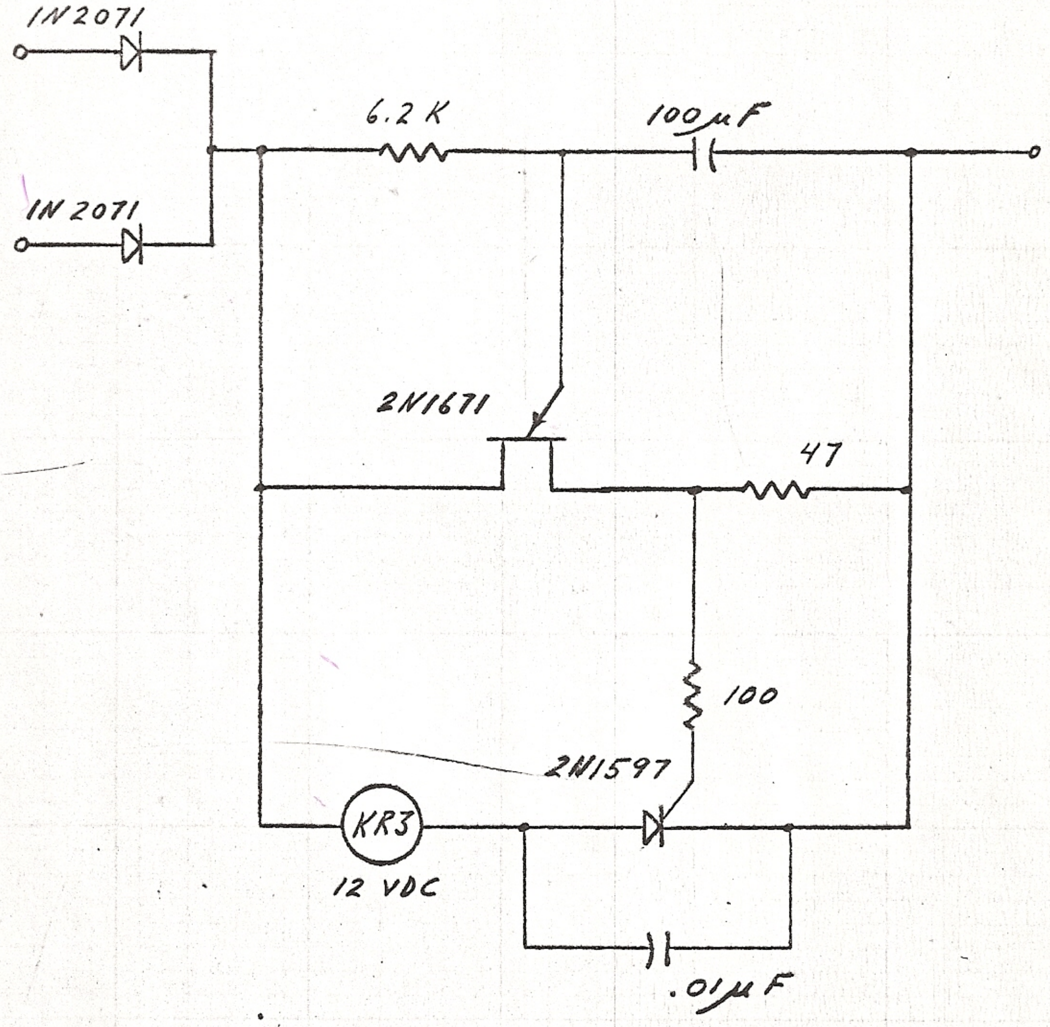
1N2071
1N2071
6.2 K
100 µF
2N1671
47
100
2N1597
KR3
12 VDC
.01 µF

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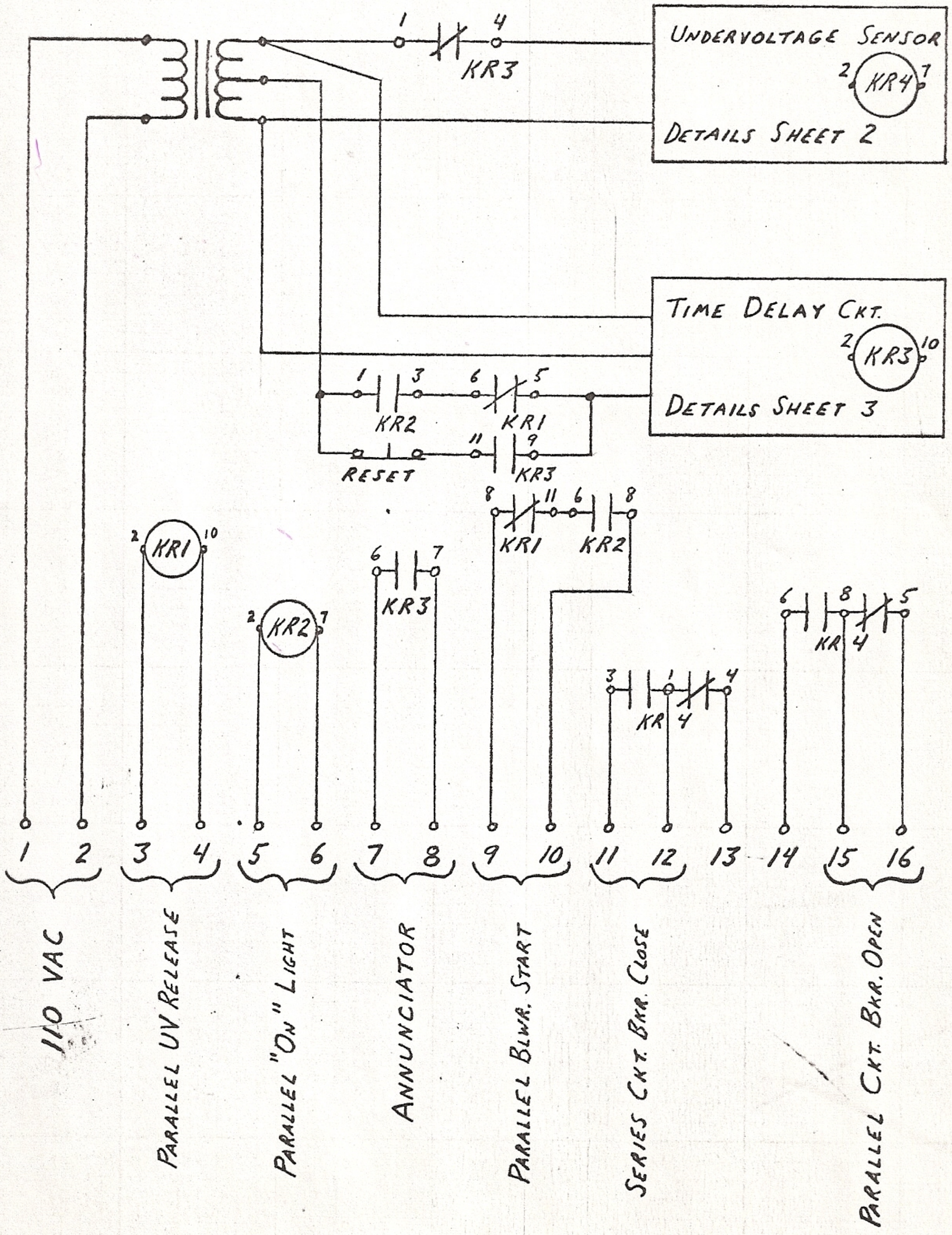

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