

FEASIBILITY TEST: FAST BACKLEG BEAM DEFLECTION

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A test was conducted to determine whether a fast (1.0 msec max.) orbit perturbation could be generated using a backleg winding. However, suppose a pulse is applied to a backleg winding thus generating a voltage in that main winding. This voltage would be dropped across the windings of the rest of the magnets in the ring. The resulting counter-acting flux change would completely nullify the flux change in the initial magnet if there were no flux leakages, and if the shunt capacitances and magnet inductances formed a lossless delay line. Thus, the object of the test was to determine the transmission characteristics of the magnet ring to a step input to a backleg winding and its departure from an ideal LC line.

A simple test circuit was built which does the following. A large capacitor, C_0 , is charged through the normally closed contacts of a mercury relay. Approximately once per second the relay is energized connecting the charged capacitor across a 5-turn backleg winding. The specific magnet used for the test was at E-6. Photographs of the response across the main windings of E-6, E-5, E-4, E-3 and E-1 were taken using the A-B function of a TEK 454 scope. These voltages were numerically integrated to obtain $2\int V_0 dt$, $\int V_1 dt$, $\int V_2 dt$, $\int V_3 dt$ and $\int V_5 dt$ respectively. An extrapolation was made to obtain values of $\int V_n dt$ for which the response was not measured. These were combined to form

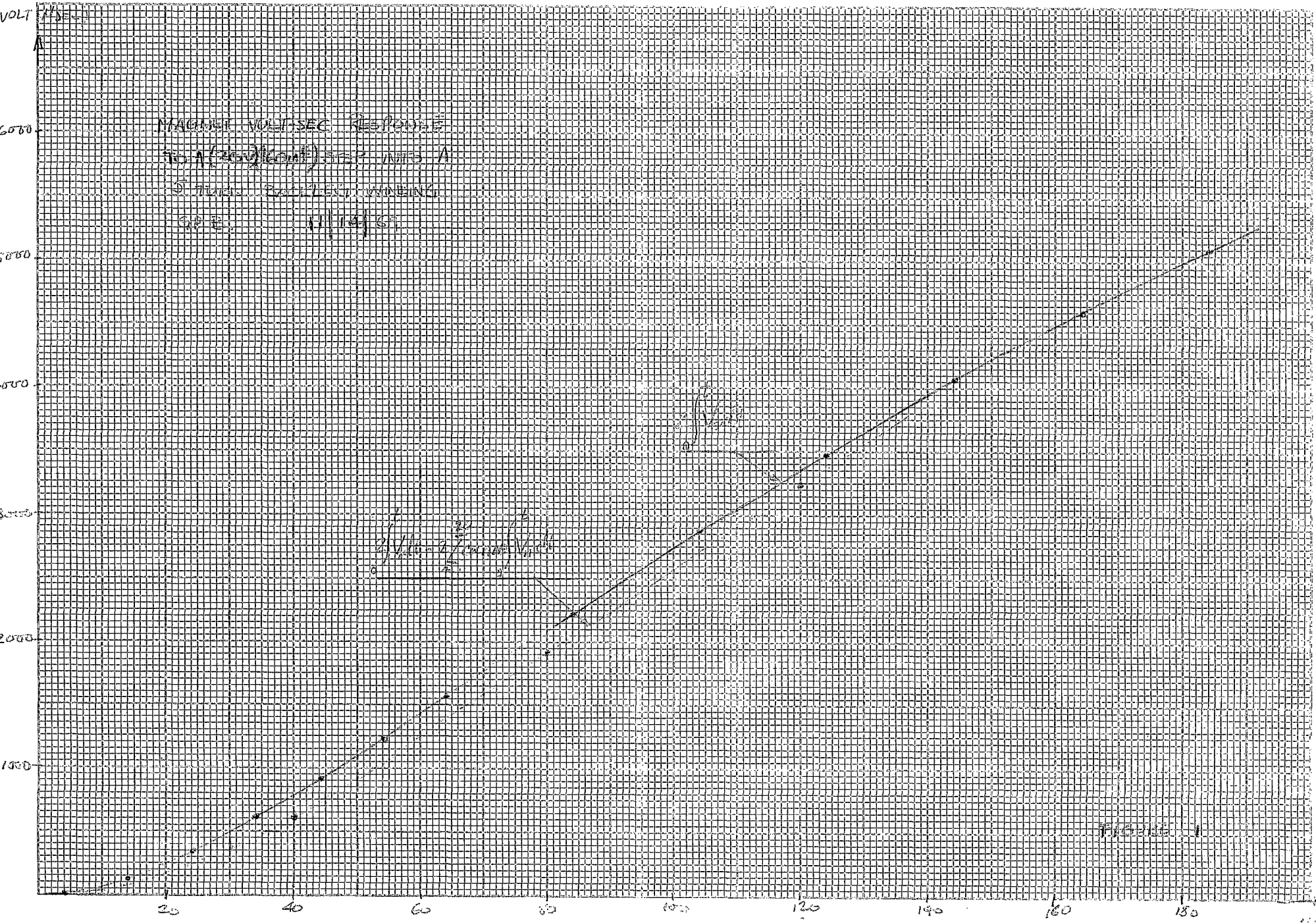
$$2 \int_0^t V_0 dt - 2 \sum_{n=1}^{18} \cos n \Delta\theta \int_0^t V_n dt$$

which is proportional to the angular change the beam orbit should experience at the time t for the voltage applied as it passes through this series of magnets. $\Delta\theta$ is $13.15^\circ/\text{magnet}$ assuming a v of 8.75. This result is plotted in Fig. 1.

The rise of the response at the main winding of E-6 is slowed by the leakage inductance which introduces a time constant of $(1-k^2) L/R \approx 21 \mu\text{sec}$ causing V_0 to be a poor step, where L is the main winding inductance and R is the resistance across the coil packs. However, if V_0 were a step, an analytic form for the voltage across any coil can be obtained for $t < \frac{L}{R}$. The form of the solution involves $\exp. (n^2 RC/4t)$. This was used as the basis for making the extrapolation for those unmeasured responses mentioned above. However, there is no reason to expect that the measured responses should agree closely with this calculated response.

The result of the test indicates that beam perturbations of the order of $100 \mu\text{sec}$ duration can be accomplished using this approach. The net effect of the voltage across the adjacent magnets causes a small negative correction on the beam bending effect of the field change generated in the core of the magnet energized by the backleg winding. The leakage inductance and the resistance across the coil packs effectively put a lower limit on the duration of the beam deflection.

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 1002

$\int V_m dt$
 VOLT-SEC.

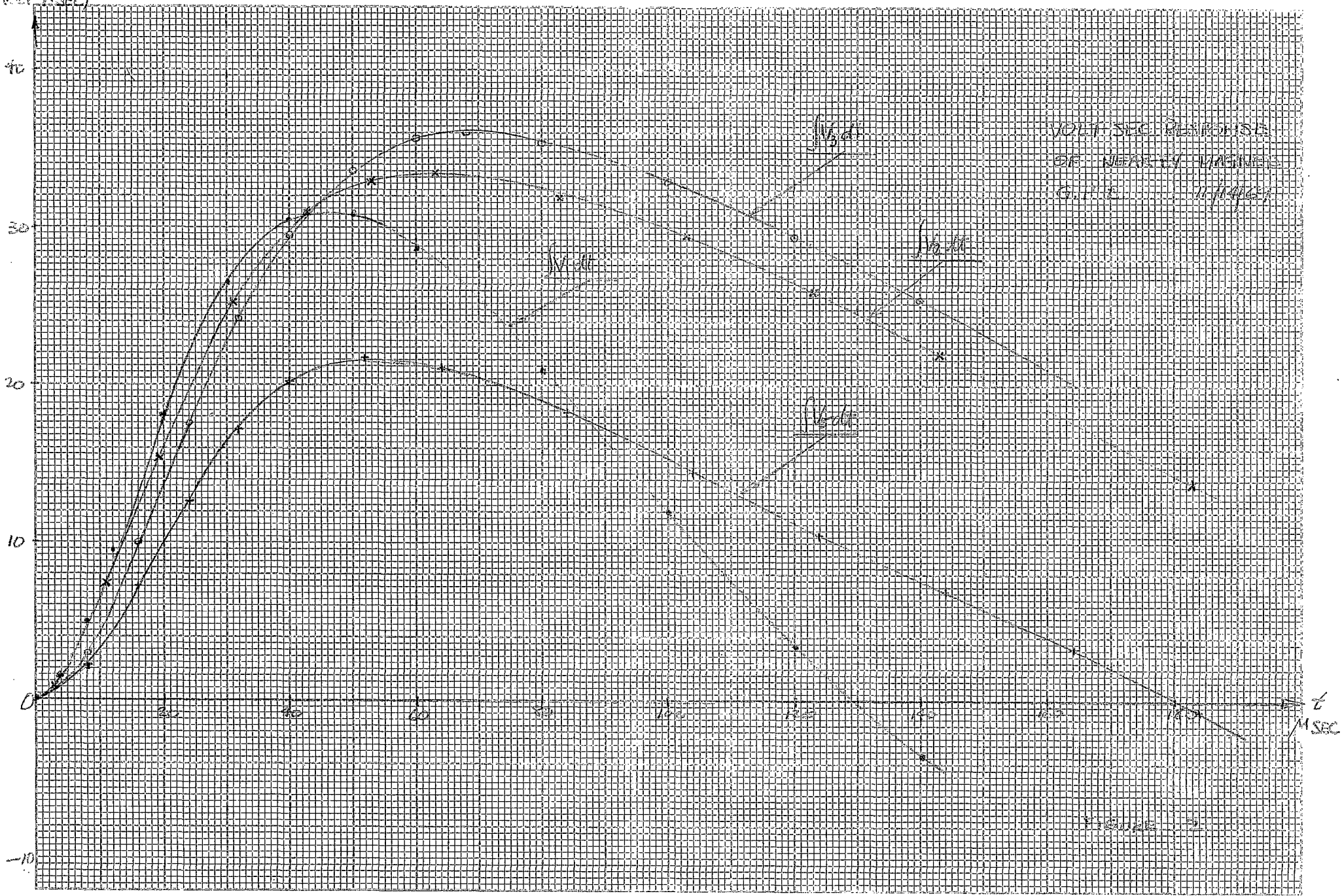
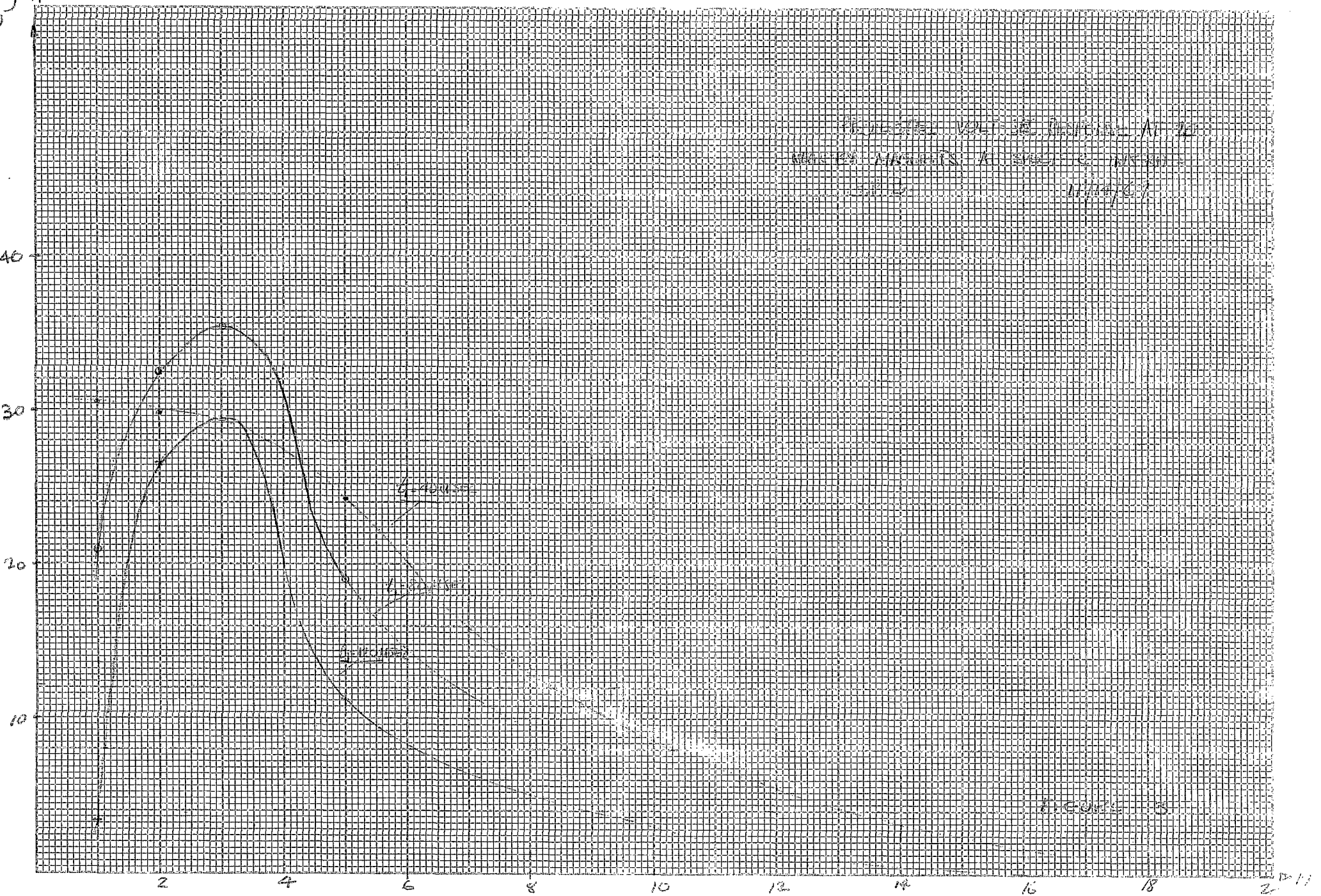


FIGURE 2

$\int_0^{t_1} V_{ind} dt$

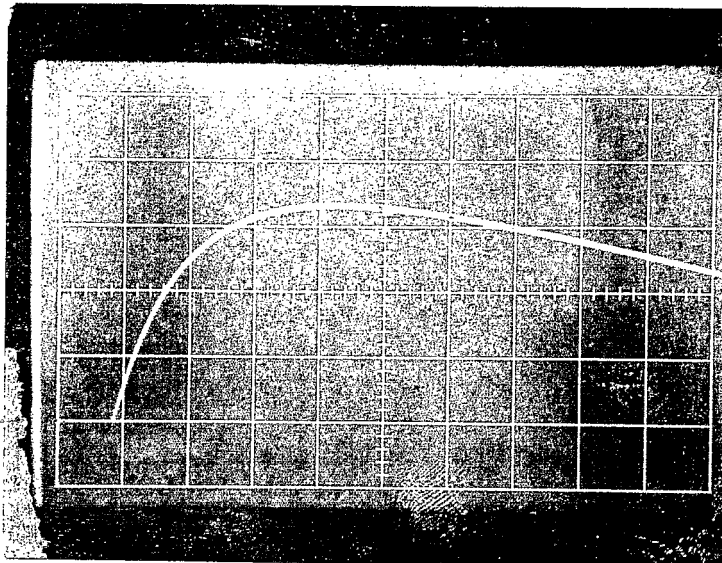


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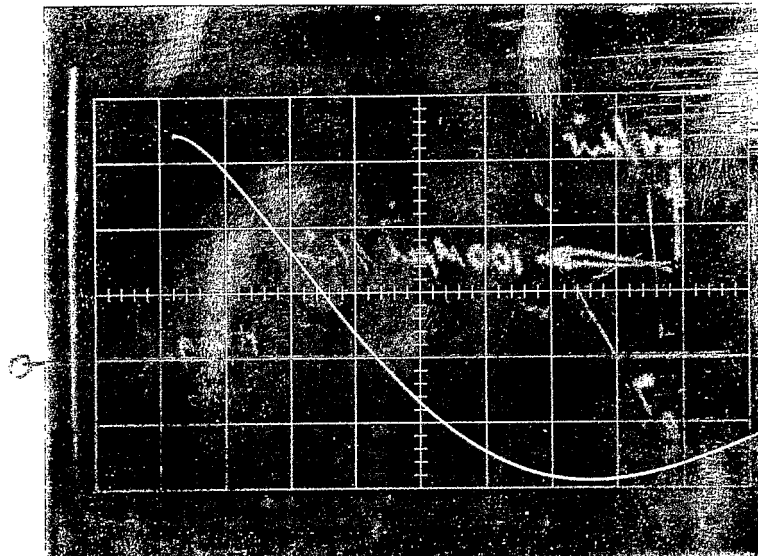
BY GPB DATE 11/11/69 SUBJECT MAGNET VOLTAGE RESPONSE TO
(20 V) (160 μ f) BACKLEG WINDING STEP
 CHKD. BY _____ DATE _____
 _____ DEPT. OR PROJECT _____

SHEET No. _____ OF _____
 JOB No. _____

$2V_0$



EG., Upper Coil Packs 10 V/Div,
 20 μ sec/Div

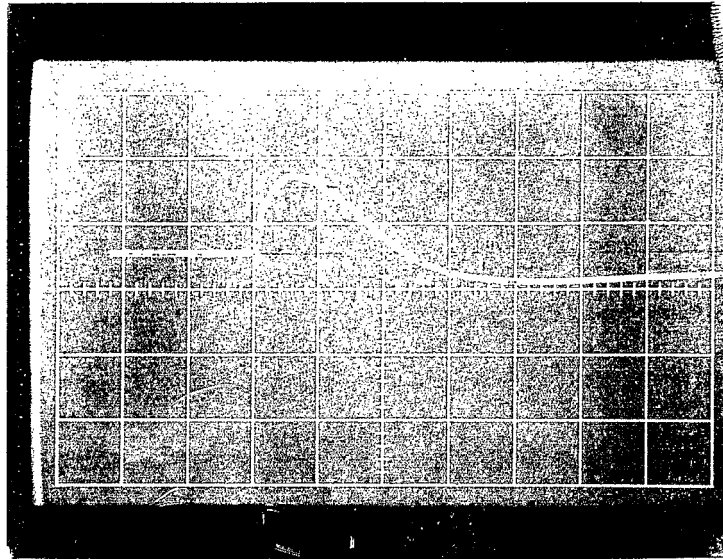


EG., Backleg Winding 5 V/Div, 100 μ sec/Div
 160 μ f Charged to 20 V

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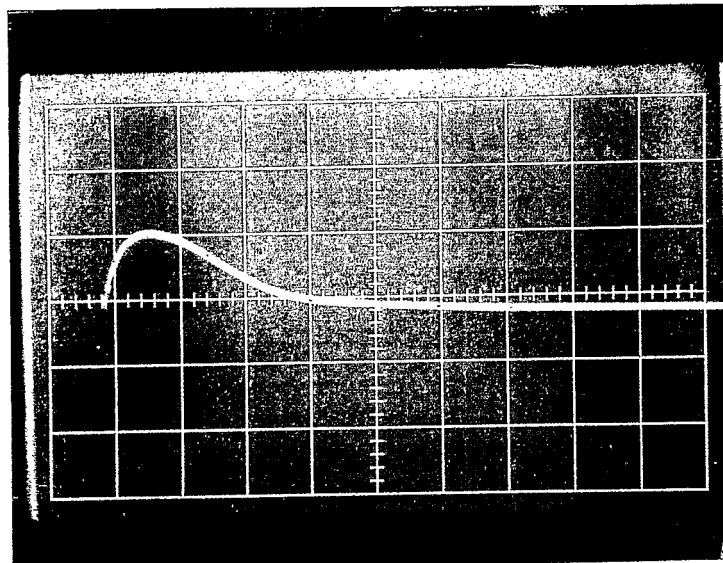
BY GPB DATE 11/11/69 SUBJECT NEAR BY MAGNET VOLTAGE RESPONSE SHEET No. OF
 CHKD. BY DATE TO BACKLEG WINDING STEP JOB No.
 DEPT. OR PROJECT

V₁



E5, Lower 1.0 V/Div, 20 μ sec/Div

V₂



E4, Upper 1.0 V/Div, 20 μ sec/Div

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BY GPB DATE 11/11/69

SUBJECT NEAR BY MAGNET VOLTAGE

SHEET No. OF

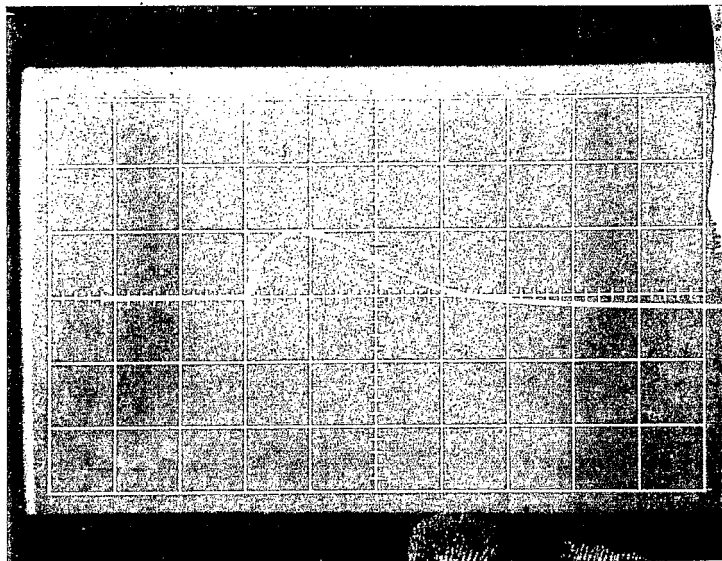
CHKD. BY DATE

RESPONSE TO BACKLEG WINDING STEP

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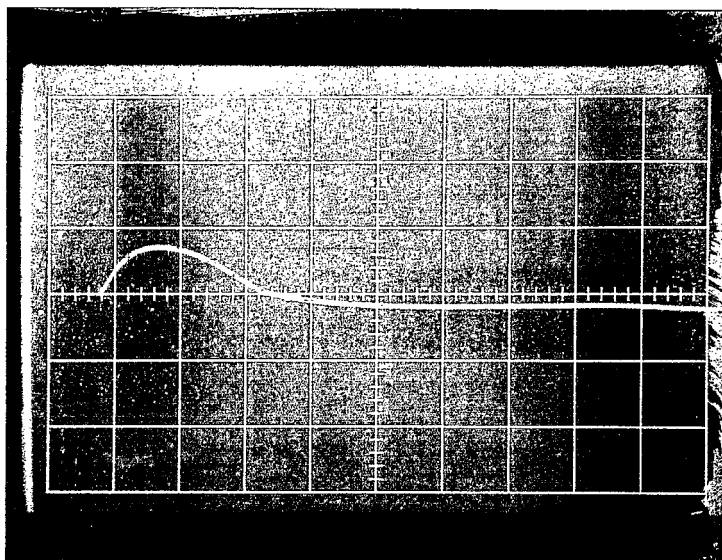
DEPT. OR PROJECT

V₃



E3, Lower 1.0 V/Div, 20 μ sec/Div

V₅



E1, Lower 1.0 V/Div, 20 μ sec/Div