Title
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Authors
Wells, D.Kenneth
Johnson, Rudin.

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Electrons are injected into the synchrotron by an electron gun pulsed with about 110 kv. The energy of the electrons accepted by the machine depends on the magnetic field, which is a function of time. The voltage pulse is formed by a pulse line and transformer, and in the past has had a shape such as shown in Fig. 1. From the figure it can be seen that only a small part of the pulse has an optimum voltage--that is, at which the two curves can be made to coincide for the maximum length of time. If the two curves could be made to coincide over a longer period we should be able to get more electrons accepted by the machine and thereby increase the beam intensity.

In order to determine the acceptance-energy curve, the injector pulse line was temporarily modified to give a narrow pulse of 110 kv. The pulse timing was adjusted to give maximum beam intensity and the pulse then was photographed. The voltage was then lowered and the timing readjusted for maximum beam, and again the pulse was photographed on the same plate. This was repeated at several lower voltages; each time the scope and camera settings were left the same. This produced a multiple-exposure photograph, as shown in Fig. 2. The envelope of the peaks was assumed to give a curve of the acceptance energy.

The pulse was shaped to match this by moving capacitor taps on the pulse-line coil (Fig. 3). This did indeed almost double the beam intensity. However, we wanted to be able to optimize the slope by varying it slightly when the beam was on. We wanted also to be able to reduce the slope when the machine was run at lower energies. For this purpose a new variable-slope pulse line was built.

The variable-slope pulse line consists of 16 coils wound on two forms (see Fig. 4). Each coil is 1 in. long and 1-1/2 in. in diameter, and they are separated by 1 in. The number of turns per coil decreases (in several steps, as shown in Fig. 4) from the beginning of the line to the end. Copper cores are mounted on a pair of wooden rods, which are in turn mounted on a cross bar that is driven by a small motor, so that all cores move simultaneously inside both forms. When the rods are moved one coil length some of the cores move from inside to between the coils and others move from between to inside. The cores are arranged on the rods so that the coils at the beginning of the line are going to maximum inductance while the coils toward the end are going to minimum. There are no cores for the coils in the central part of the line.

The capacitance of the line is provided by several television high-voltage capacitors connected in parallel between each coil. The number of capacitors at each point was adjusted to obtain a smooth pulse. All together, 88 capacitors were used, each of 500$\mu\mu$f and 30 kv.

The pulse produced by the new line is shown in Fig. 5 with maximum and minimum slope. The slope can be varied smoothly between these two extremes and the beam maximinzed at full energy as well as low energy. Since some of the coils are increasing in inductance while others are decreasing, the pulse length remains nearly constant.

Figure Legends

Fig. 1. Injector voltage pulse and acceptance energy.

Fig. 2. Envelope of voltage peaks, giving acceptance energy.

Fig. 3. Pulse shape achieved by adjustments of capacitor taps.

Fig. 4. Sketch of the pulse line. The number of turns is shown beside each coil. Only the top layer of capacitors is indicated; there are several layers below. The capacitance total at each point is shown.

Fig. 5. Maximum and minimum slope produced by the pulse line.

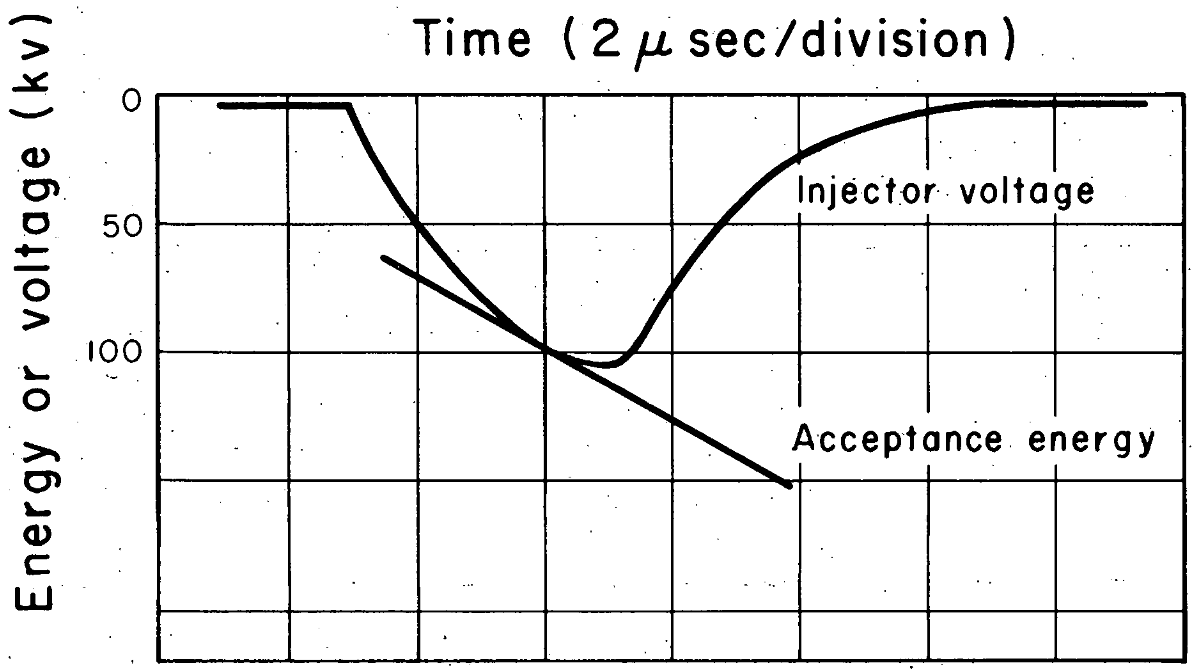
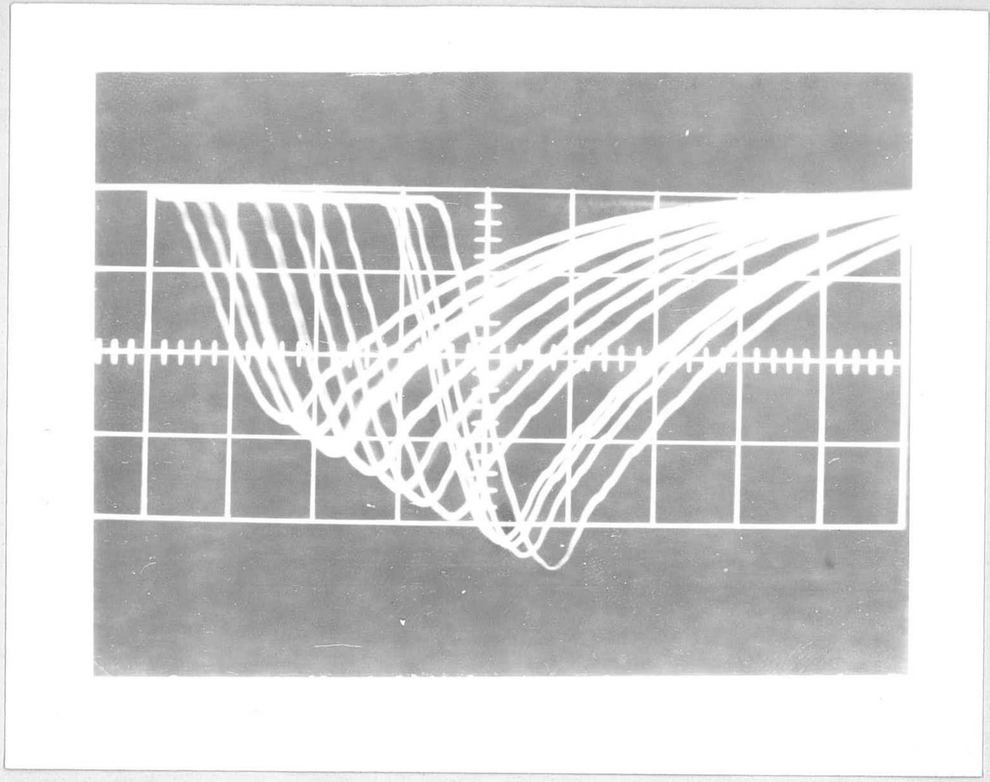

Time (2 μ sec/division)
Energy or voltage (kv)
0
50
100
Injector voltage
Acceptance energy

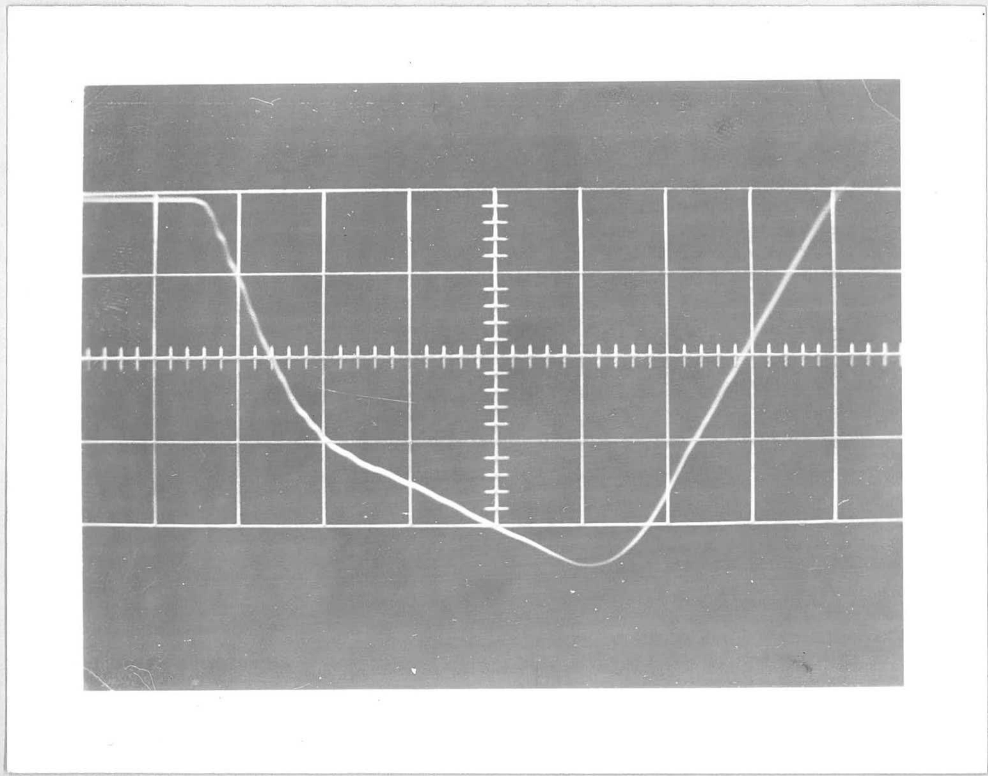
Fig. 1
56,714-1

Voltage (25 kv/cm)



Time (1 μsec/cm)
Fig. 2

Voltage (25 kv/cm)



Time (1 μsec/cm
Fig. 3

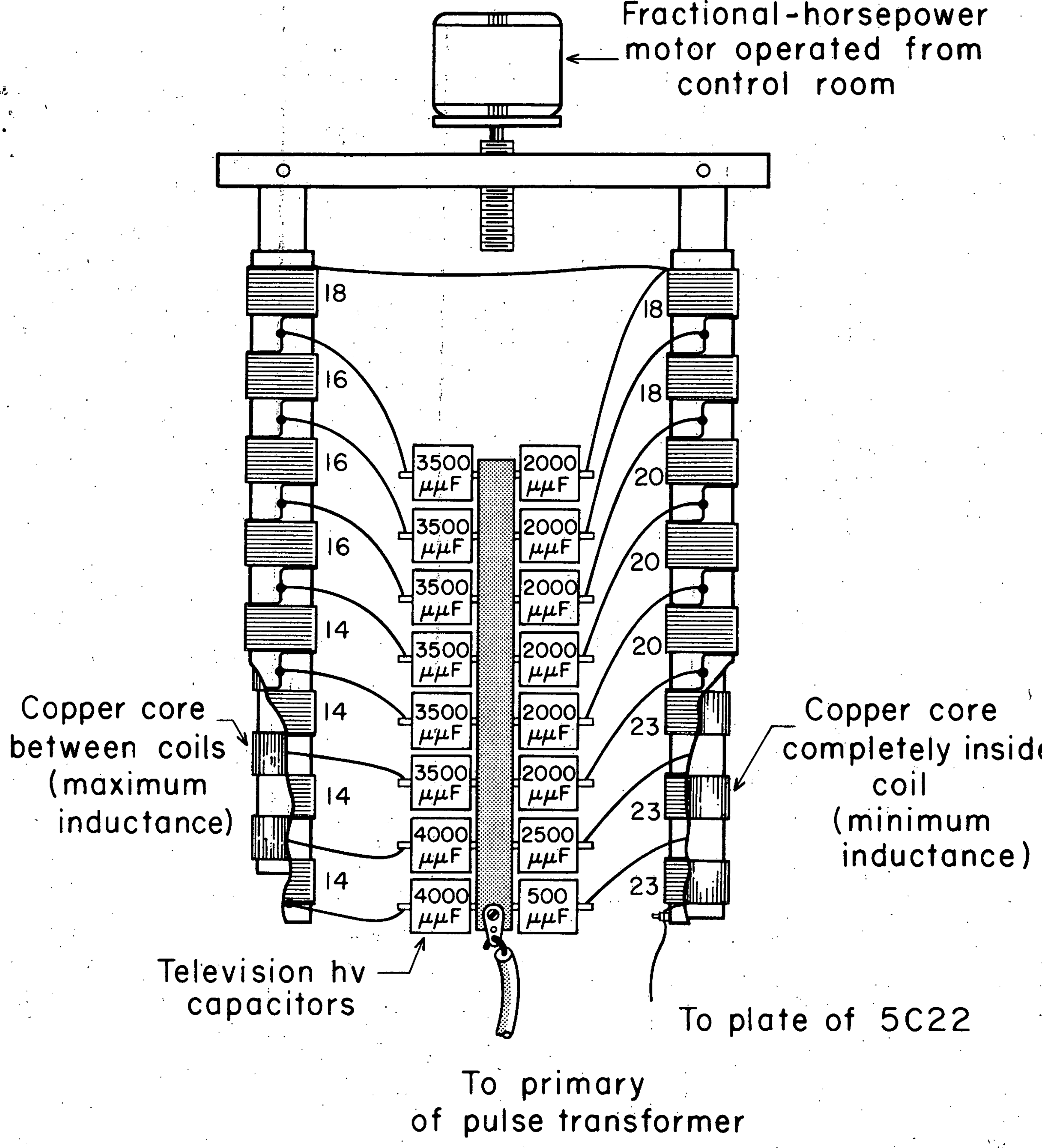
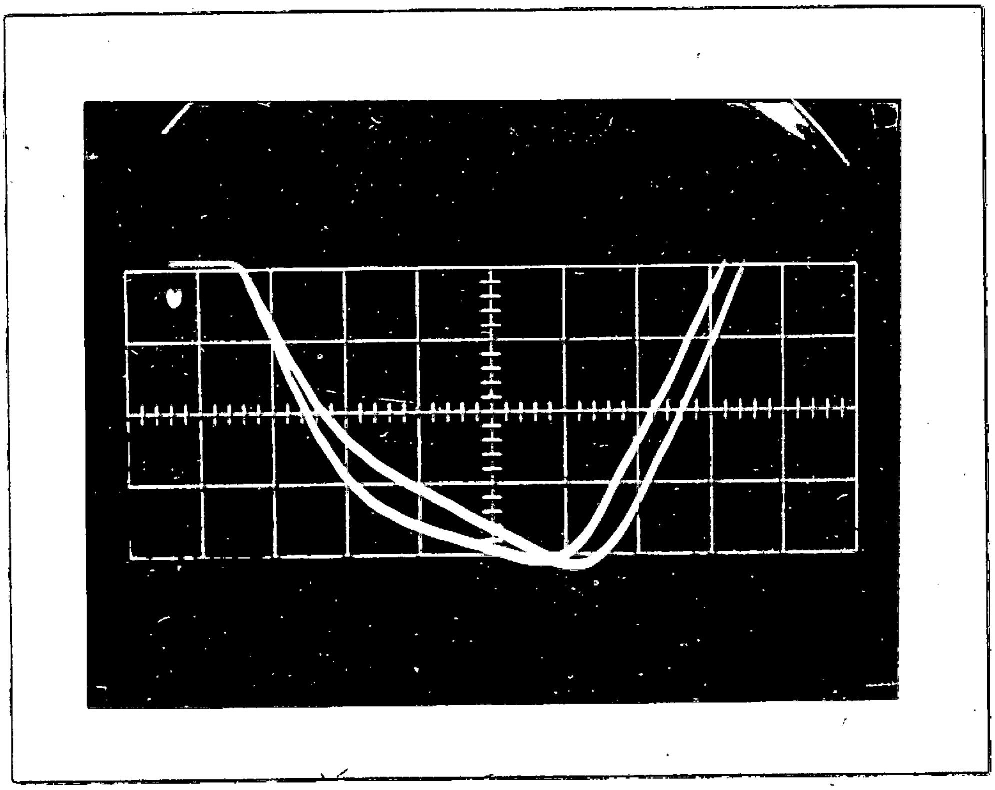

Fractional-horsepower motor operated from control room
18
16
16
16
14
14
14
14
18
18
20
20
20
23
23
23
3500 μμF
3500 μμF
3500 μμF
3500 μμF
3500 μμF
3500 μμF
4000 μμF
4000 μμF
2000 μμF
2000 μμF
2000 μμF
2000 μμF
2000 μμF
2000 μμF
2500 μμF
500 μμF
Copper core between coils (maximum inductance)
Copper core completely inside coil (minimum inductance)
Television hv capacitors
To plate of 5C22
To primary of pulse transformer

Fig. 4
56,715-1

Voltage (25 kv/cm)



Time (1 μsec/cm)

Fig. 5