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INSTRUMENTATION - Project M

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The general tendency is toward a highly simplified control and monitoring system. Nevertheless, experience gathered on Mark III points toward the need of occasional control and monitoring of single sections of the accelerator by the Chief Operator. This means that he must have at his disposal in the main control room means enabling him to assume control of any part of the accelerator, if need arises.

Such single connections with parts of the accelerator do not require recourse to telemetering, but a rather simple relay system seems adequate.

Two rough estimates have been made (with the accent on "rough"), the first of which concerns the above mentioned case. In Fig. 1 a schematic diagram of the circuit is given. According to it, along the accelerator 240 sources of information, supplying 5 data each, can be connected, one at a time, to a display existing in the main operating room by means of a telephone-type selector system. Controlled by it, a multiple relay connects the selected information source to a 5-wire bus system (out of which one is a coaxial cable for the video signal). This latter is directly connected with the main operating room. Two such systems are needed: one for monitoring, the other for actual control.

The cost estimate is the following:

| | <u>Unit</u> | <u>Total</u> |
|---|----------------|------------------|
| .3 miles, coax. cable & 4-conductor cable | 0.25/ft | 3,000.00 |
| .240 pc. relay units | 50.00 | 12,000.00 |
| .240 pc. selectors & auxil. relays | 100.00 | 24,000.00 |
| .240 function selector unit | 2000.00 | 2,000.00 |
| .1 display (oscilloscope + 4 meters) | 2000.00 | 2,000.00 |
| .720 men-hour, 3 men, 30 days | 4.00 | 2,880.00 |
| | | <u>46,812.00</u> |
| | Unforeseen 15% | 7,021.80 |
| | TOTAL COST | <u>53,833.80</u> |

The cost is almost doubled by the need of a second nearly identical system for control purposes, as mentioned above. If in such an estimate, even the synchro control means are included, the cost goes up accordingly.

A second estimate has been made for purposes of comparison. It may be considered also as complementary to the first estimate. It concerns means for the simultaneous display in the main operating room of information pertaining to 240 sources, each supplying 4 bits of data, none of which are video. This is a telemetering system schematically represented in Fig. 2. According to it, the same source which supplies 360 pulses per sec. to the accelerator and its components, controls sampling circuits gathering 4 data from each of 240 information sources. Time division is obtained, both on the transmitting and the receiving end, by pulse delay networks. Time delays and attenuation in connecting cables are equalized by line amplifiers. A special 4 line, 240 holes per line display and memory is used as readout. The following estimate may give an idea of the cost involved in this system:

| | <u>Unit</u> | <u>Min.</u> | <u>Max.</u> |
|---|----------------------|-----------------|-----------------|
| 9 + 1 pulse shapers and/or repeaters | 200-300 | 2,000. | 3,000. |
| 1 pulse shaper and freq. multipl. | 500-600 | 500. | 600. |
| 240 samplers | 200-300 | 48,000. | 72,000. |
| 240 amplifiers & cable length equal. | 200-250 | 49,000. | 60,000. |
| 240 4-tape delay networks | 30-40 | 7,200. | 9,600. |
| 1 4-channel gate | 300-400 | 300. | 400. |
| 6 miles coax. cable | 0.10-15/ft | 3,150. | 4,725. |
| 1200 man-hour, 5 men, 30 days | 4.00 | 4,800. | 4,800. |
| | | <u>113,950.</u> | <u>135,125.</u> |
| | | 17,092. | 23,268. |
| | | <u>131,042.</u> | <u>158,393.</u> |
| | Unforeseen 15% | | |
| | COST without display | | |
| <u>DISPLAY:</u> | | | |
| 1) 960 pidgeonhole display & memory | 30-40 | 7,200. | 9,600. |
| 240-tape delay network | 20-25 | 19,200. | 24,000. |
| or | | | |
| 2) Oscilloscope, 27" tube | 3000-4000 | 3,000. | 3,000. |
| First alternative (with 960-hole display) | | 157,442. | 211,993. |
| Second alternative (with oscilloscope) | | 134,042. | 162,393. |

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While such a system could be used for monitoring, the system to which the first estimate is related could be employed for controlling.

It must be noted that this second system does not comprise any video monitoring, because it cannot be superimposed, i.e., it requires a separate video system. This may be again of the selector-relay type by which one source of video signal can be selected at a time. The cost may run at about 1/3 of the first estimate, i.e., at \$27,000.00.

The foregoing two cases represent two extremes. An intermediate solution would be a system according to which a group of information sources, say 10 or 12, at a time, are connected to the main operating room. In this case, while the connection is made through relays and selectors the actual monitoring is obtained by telemetering. The cost is approximately the sum of the costs of the two extreme solutions, i.e.

| | |
|---|------------------|
| for groupwise connections (see 1st case) | \$54,000.00 |
| for telemetering these groups (see 2nd case average) | 171,000.00 |
| for 1 video channel and delay line | <u>27,000.00</u> |
| | 252,000.00 |

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