To show how data reduction procedures fit in our work, let us look at the first slide. (Slide 1) The work here, as at any large laboratory, naturally divides into analytical and experimental phases. After a research project is started and the experimental and analytical work progresses, the results are studied and compared so as to provide the information which is used to plan additional work. Both the analytical and experimental phases require computational procedures. The computations for the analytical phase are in general very extensive and of an involved nature, and therefore require fast, automatic, high-capacity computers.

In use at the Laboratories, we have several IBM electronic card-programmed calculators, a Bell digital computer, which incidentally runs three shifts, as well as Reac, Philbrick and other analog machines. The Laboratories also make use of high capacity computing machinery at other government, commercial and university locations.

In contrast to analytical computations, the processing of experimental data involves calculations of a relatively simple nature applied to an extremely large number of points.

Handling test data, however, involves much more than just numerical computations. Our major interest is to measure the physical quantities and from the test data to derive the final results of the experiment. This requires a number of steps, such as those shown here, which are detailed on the next slide. (Slide 2) These steps have generally been carried out manually, but the tremendous volume of tedious work makes it necessary to devote a good deal of effort to the elimination of manual procedures.

We must not lose sight of the fact that the measurement must be made satisfactorily. Instruments which satisfactorily meet the requirements of accuracy, reliability and over-all economy are used to convert the data into a signal which is then recorded. The records are edited and read, calculations are made and finally tabulations and plots are prepared.

The series of steps which is used varies from test to test; for instance, the steps required to process wind-tunnel data will be different from those used to process flight or rocket-powered model data. What we're trying to do is to mechanize as much of this as possible. However, there are certain aspects of the work in which a machine cannot make an intelligent decision. For example, manual editing makes it possible to monitor and control the quality of the records and to reduce unproductive calculations.

We therefore use a number of techniques to automatically or semi-automatically assist in the data reduction. For instance, we record the data in more advanced form, that is, with a certain amount of combining and computing already done. We also use a number of devices to semi-automatically carry out the various steps of the data reduction process and finally we funnel the material through automatic calculating machines. As an example of the by-passing of steps of the data reduction process, let us look at the next slide (Slide 3). Here it is desired to obtain

the aerodynamic forces and moments on a wind-tunnel model. The forces are sensed by electric strain gages on the internal balance and the strain gage signals are combined in weighting networks. From these networks we operate the indicators for the tunnel operator and the punched card recorder. This arrangement is typical of those in which a number of the data reduction steps are combined. This equipment will be shown at the display after lunch.

Another illustration is shown on the next slide, (Slide 4) which represents the case in flight or in wind-tunnel testing where a plot of the variation of pressure on the wing is required for study. The pressures are sensed by optical pressure pickups, which throw spots of light on a film in such positions that the pressure diagram is recorded directly. Here again we have a device that has eliminated manual operations and has by-passed individual data reduction steps. You will see motion pictures of pressure diagrams taken with this equipment later on today.

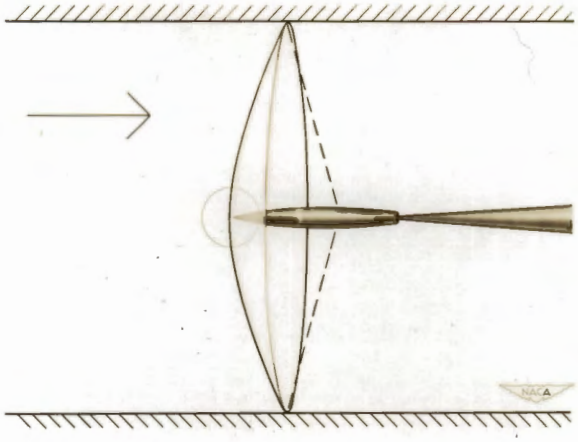
Data reduction aids may be part of a system which processes all of the related test information. The next slide shows how the data from our rocket-powered models is processed. The telemetered information from the rockets is recorded by oscillographs and is then converted to punched cards. The data provided by the Doppler radar are recorded on a magnetic tape, and a device which you will see after lunch converts this raw displacement data into velocity data from which other cards are punched. Similarly, the position radar data which are in photographic form and the radiosonde charts are converted to punched cards.

The preparation of the punched cards is carried out by using manual and semi-automatic card punches. It is at these points that we can edit and screen the raw data. With all the necessary information in punched card form, the data are then automatically processed and tabulated by an IBM electronic calculator. The punched cards are also used to automatically plot graphs if they are desired. This then is a case where manual steps remain in the process because of their effectiveness, yet all the data are funneled through an automatic calculator.

The reduction processes used are continually being studied and reviewed to strike the proper balance between quality, reliability and economy of time, personnel and funds. In the course of development a number of interesting devices have been built, and are now in use. During the lunch period you will have an opportunity to see some of these data reduction aids as well as a variety of instrument components.

Morton J. Stoller

(Typed 5-25-51, ebb)



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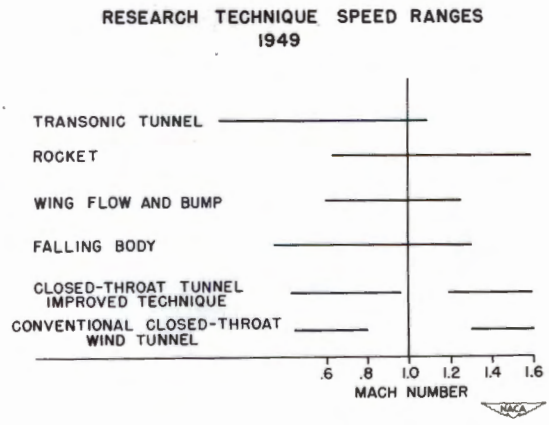

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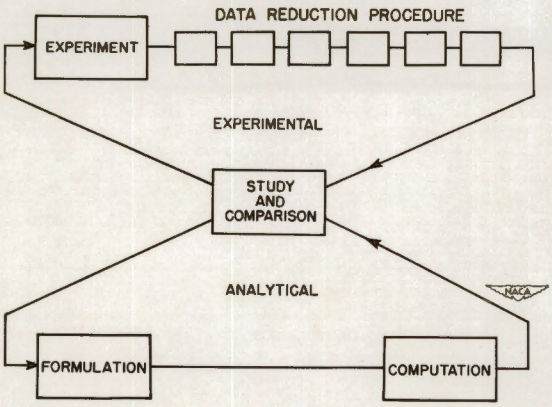

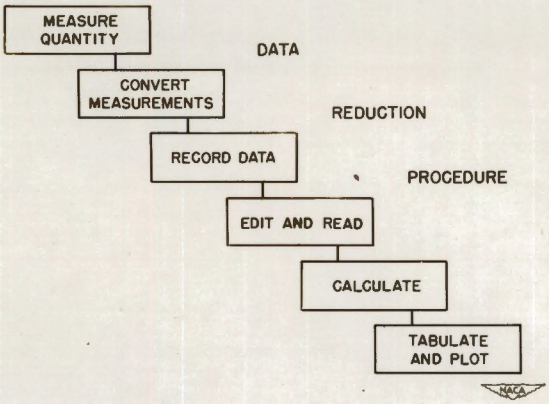

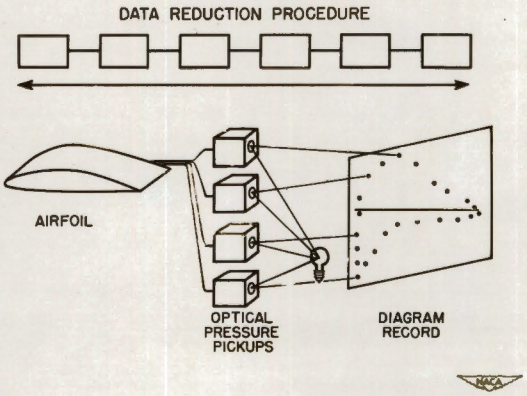

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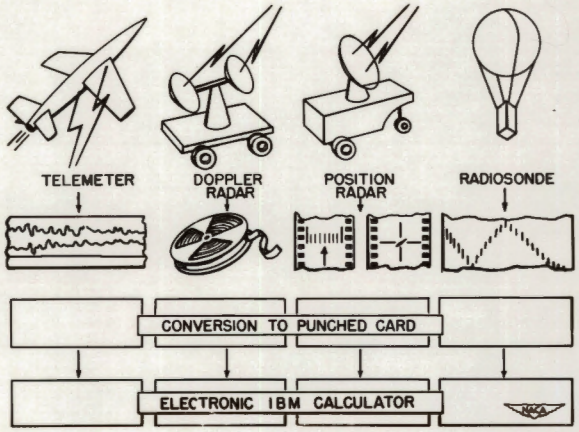

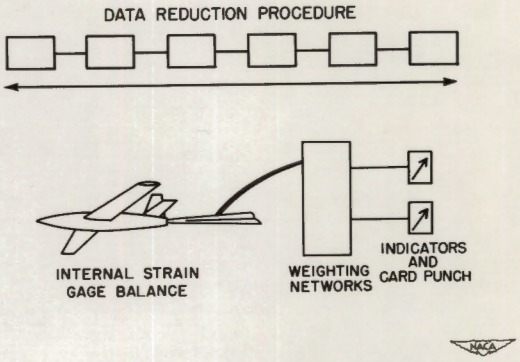

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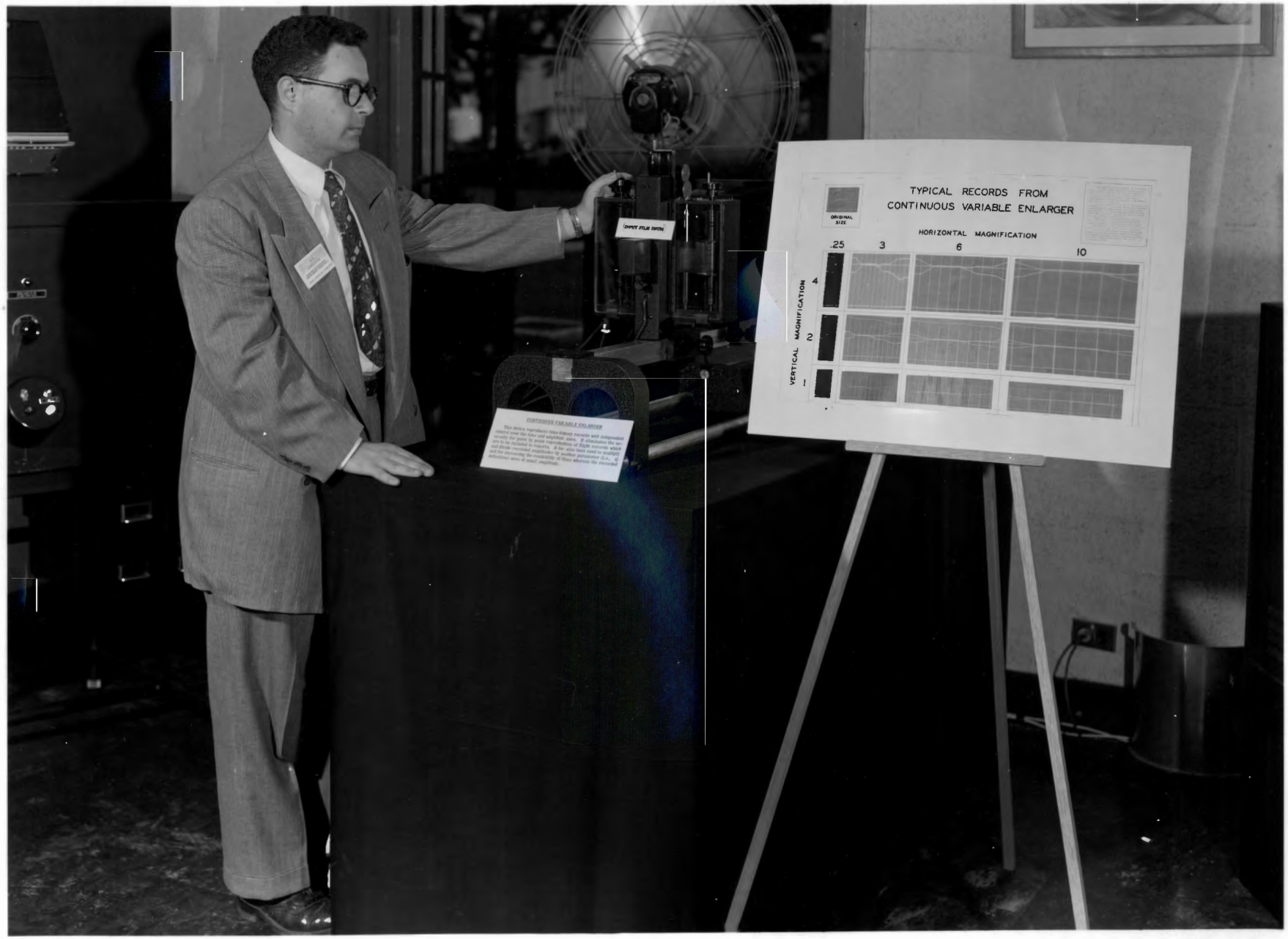
DATA REDUCTION DISPLAY

Set Up in Lobby of Activities Building



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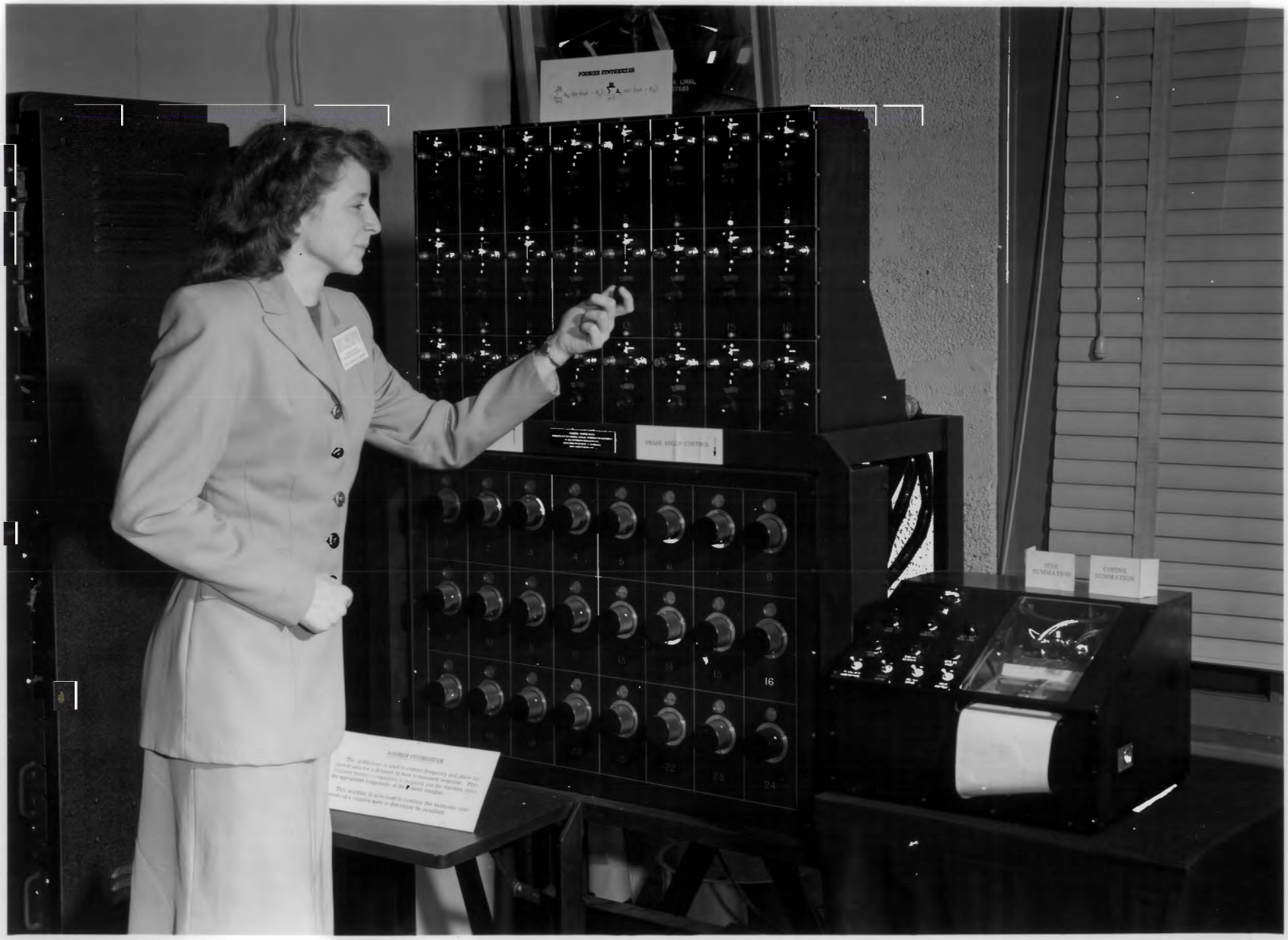

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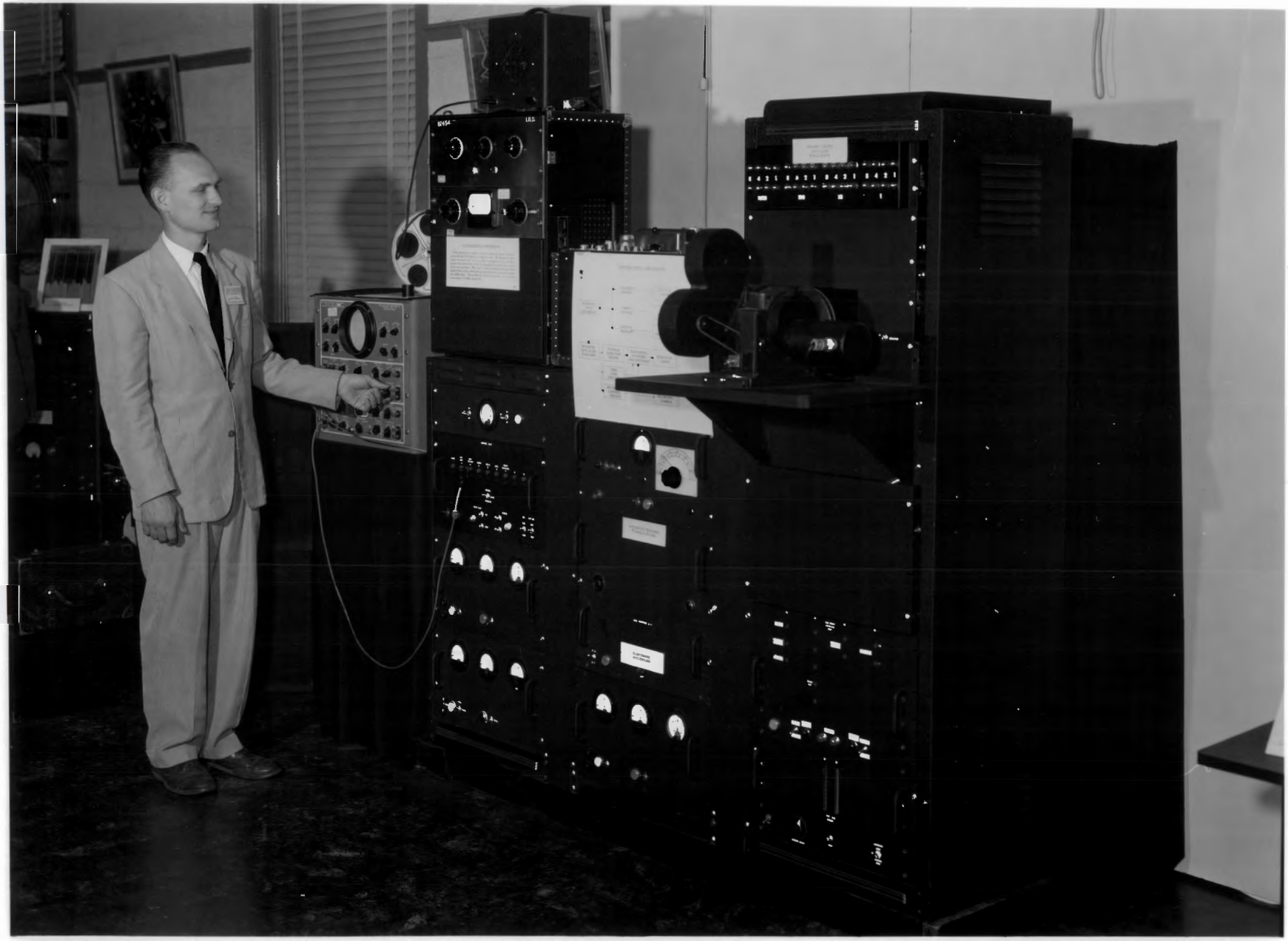

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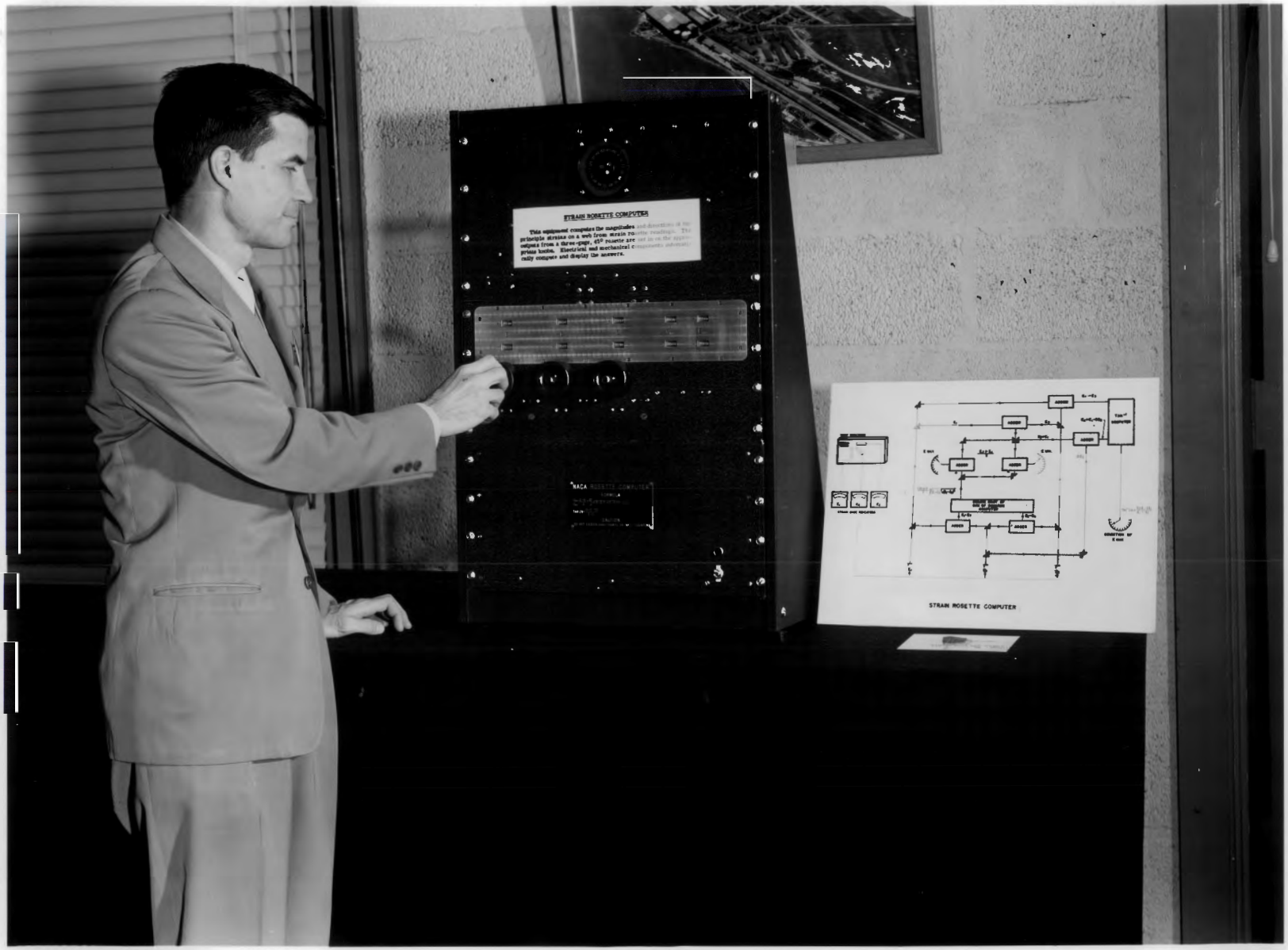

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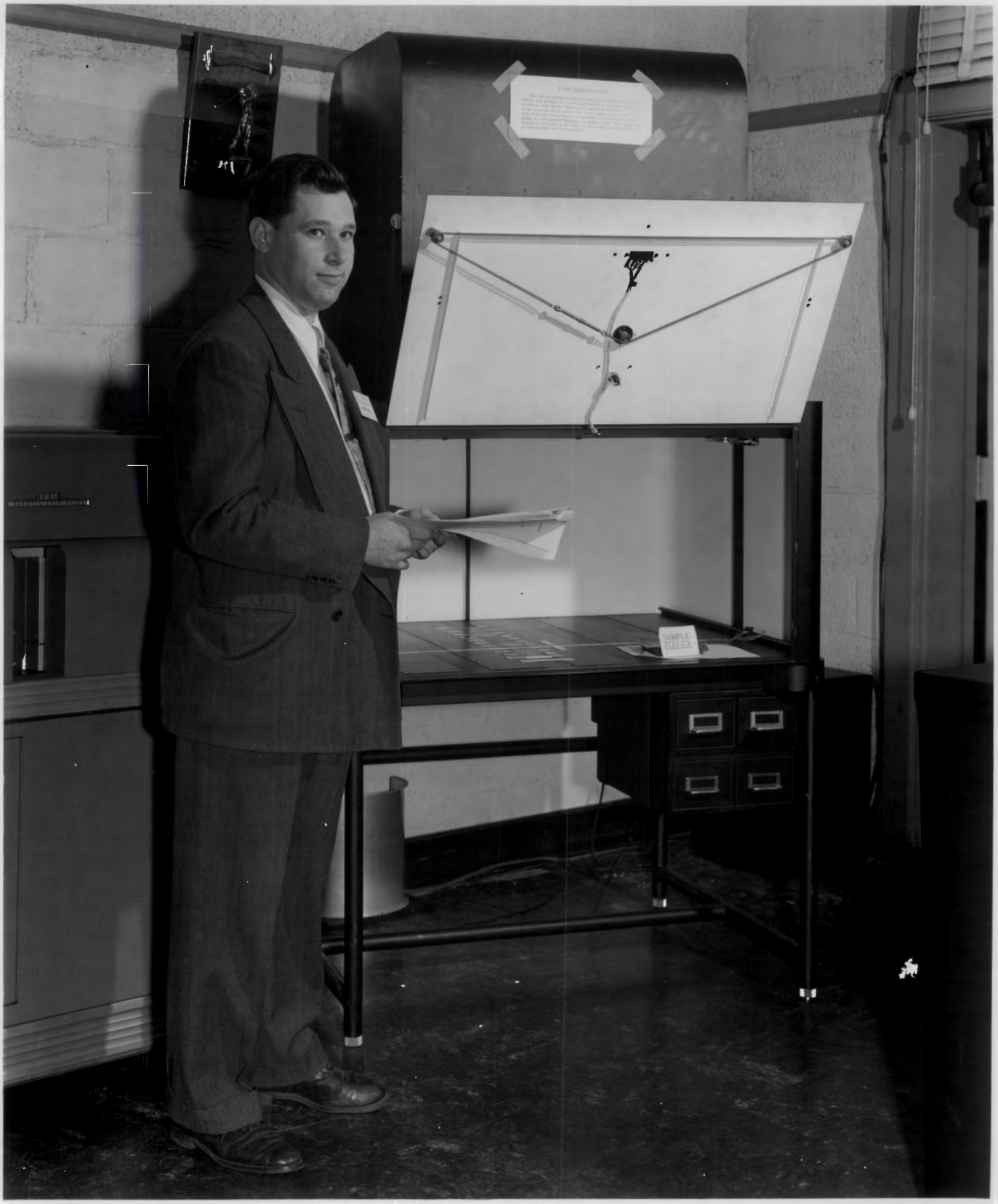

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