DESIGN AND CONSTRUCTION OF A RESEARCH MEMORY DRUM[1]

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Memory drums used in systematic investigations of human verbal learning frequently indicate a need for a variable length list as well as variable exposure time and adjustment for multiple list exposure. It is further desirable to keep inherent noises from the operation of the drum to a minimum. It is the purpose of this paper to present a design which in addition to satisfying these requirements will also provide a durable piece of equipment suitable for either individual research or for standard laboratory course use.

Of the memory drums which currently serve psychological laboratories, none is free from objection. The Hull-type memory drum (1933), in many ways the best, suffers from the use of too simple a motor, which, except for constant ratios, makes it difficult to vary exposure speeds. In addition, the necessity of vertical suspension to allow for variable list length also requires mounting the drum and elevating the S correspondingly.

The Lipmann-type drum (Woodworth 1938) is defective in all the ways that small over-all dimensions would cause; i.e., few lists on the drum at any one time, thus necessitating frequent tape changes; short variable length of list; and few possible exposure rates. The Schlosberg drum (1941) allows for only one list (constant length) on the drum, and the operation

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of the drum is quite noisy, defects that are shared by the Ranschburg exposure apparatus. The Missouri-type memory drum (McGeoch 1932) allows for a large number of lists to be placed on the drum but is not easily modified to increase the length of lists.

Each drum, then, sacrifices at least one or more variables in order to serve most effectively the limitations of size, expense, or perhaps local operational needs. The design to be reported below attempts a more adequate resolution between all of the important variables. Small overall dimensions have been sacrificed for purposes of durability and the variable of list length which here extends on the horizontal. Minimal expense has been sacrificed for the great advantages of a reliable dual speed motor.

The three important operating variables of a memory drum are: (1) the area of exposure, (2) the rate of exposure, and (3) the total number of exposures. The first step in design is the establishment of the limits of the variables. Based on the discussion above plus the anticipated use of the apparatus, the limits are set as follows:

1. Area of exposure — 0.75 in. x 6.5 in.
2. Rate of exposure — 1 sec. to 12 sec.
3. Total exposure items per list — 1 to 100.

With these values established, consideration is given to their translation into physical dimensions. The area of exposure determines the aperture size, the distance between exposures on the list, and the minimum width of the drum (equivalent, in the present case, to ten lists of typewritten three-letter words). The rate of exposure will in part determine the driving mechanism, and the latter will determine the manner in which the exposure time is established.

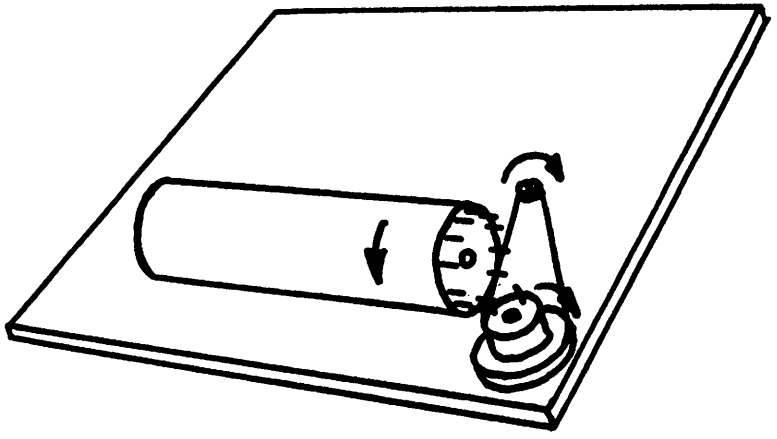

FIGURE 1. Driving Linkage

A General Industries dual speed motor[2] is selected for its durability, quiet operation, lever shift for two speeds, variable governor control, and, finally,

[2]May be purchased from Allied Radio Corporation, 833 W. Jackson Blvd., Chicago, Illinois.

because it is already geared to a usable speed. Since the motor operates at 33 rpm and 78 rpm with adjustments around these values by controlling the governor, it is a simple matter to calculate the ratio of the driving wheel to the motor and thus to determine the possible times of exposure. Power from the motor armature, which rotates about a vertical axis, is transferred to the drum, which rotates about a horizontal axis, by means of a pin driving mechanism which is similar to a bevel gear arrangement. As the motor rotates in a clockwise direction (Fig. 1) the driving wheel is turned in the same direction, and the pin, projecting vertically from the driving wheel, contacts a pin on the drum moving the drum to the next exposure. The above described action is only possible when the velocity of the pin is low. A limiting spring is used on the drum shaft to prevent overdriving the drum, and functions properly at 1 rps and a radius of 1 inch. At lower velocities, of course, the performance is not disturbed.

The use of a pin drive permits a subdivision of the exposure time by the addition of pins to the driving wheel. Table I presents the gear setting of the motor and the number of pins that are necessary to produce exposure rates per item of 1, 2, 2.5, 3, 4, 5, 6, and 12 seconds. Values have been calculated for the time required for the exposure change and have been subtracted from the total unit exposure time to obtain the desired exposure time per item. It is felt that these drum change values should be considered for any exposure device, for although the time may be small for one exposure, it becomes quite large in terms of total time for many exposures.

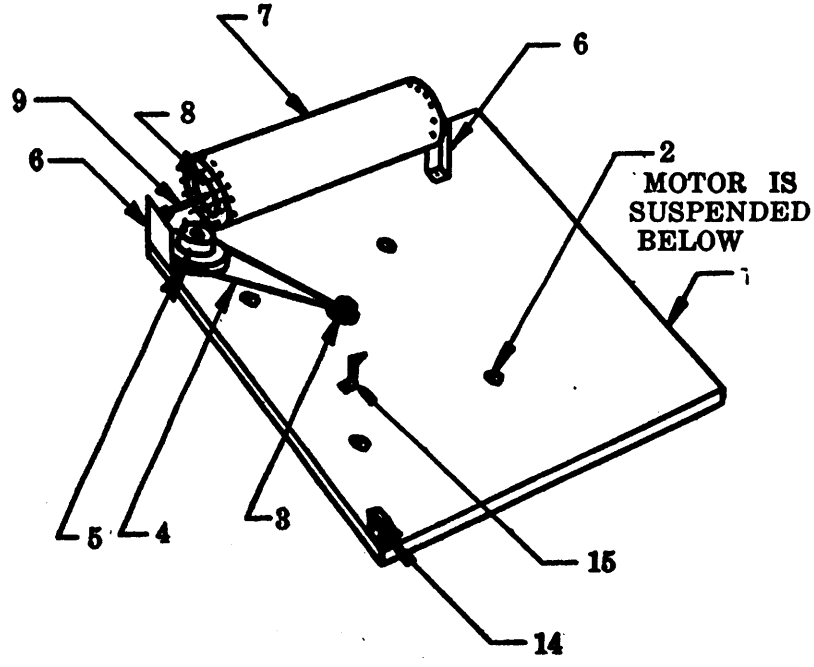

FIGURE 2. Motor Board Assembly
(See Table II for description of parts numbers)

TABLE I

Exposure Times and Settings Using a Four Inch Driving Wheel (Time in Seconds)

Actual Exposure Time	Total Time Setting per Exposure	Speed Setting of Motor	Number of Pins on Drive Wheel
12	12.39	low	1
6	6.39	low	2
5	5.19	high	1
4	4.39	low	3
3	3.39	low	4
2.5	2.69	high	2
2	2.19	high	3
1	1.19	high	4

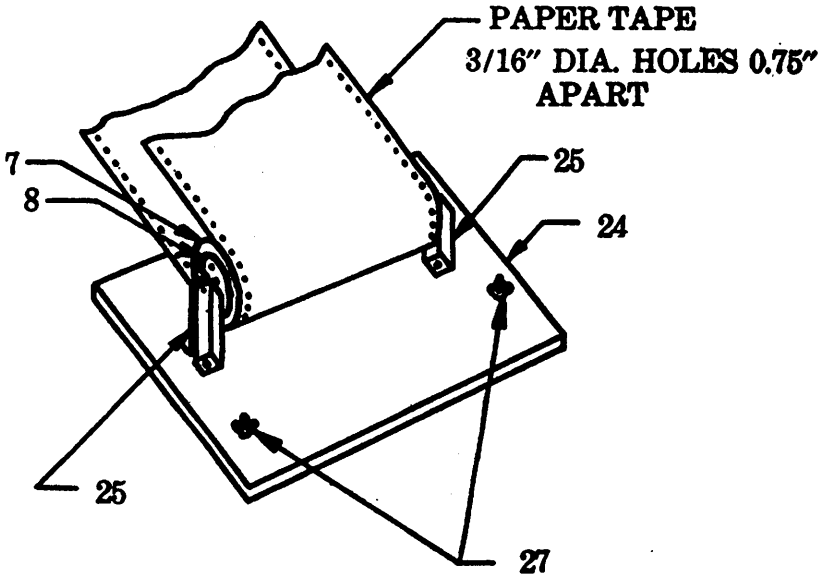

FIGURE 3. Idle Board Assembly

(See Table II for description of parts numbers)

The total number of exposure items determines the maximum length of the list, in this case 75 inches. This dimension is conveniently cut in half by the use of a paper loop operating in much the same manner as an endless conveyor belt (Fig. 4).

For convenience the mechanism is assembled in three units: the motor board assembly (Fig. 2), the idle board assembly (Fig. 3), and the housing

assembly (Fig. 4), which in addition indicates the completed installation. Table II presents the part numbers for all figures as well as further descriptive part details.

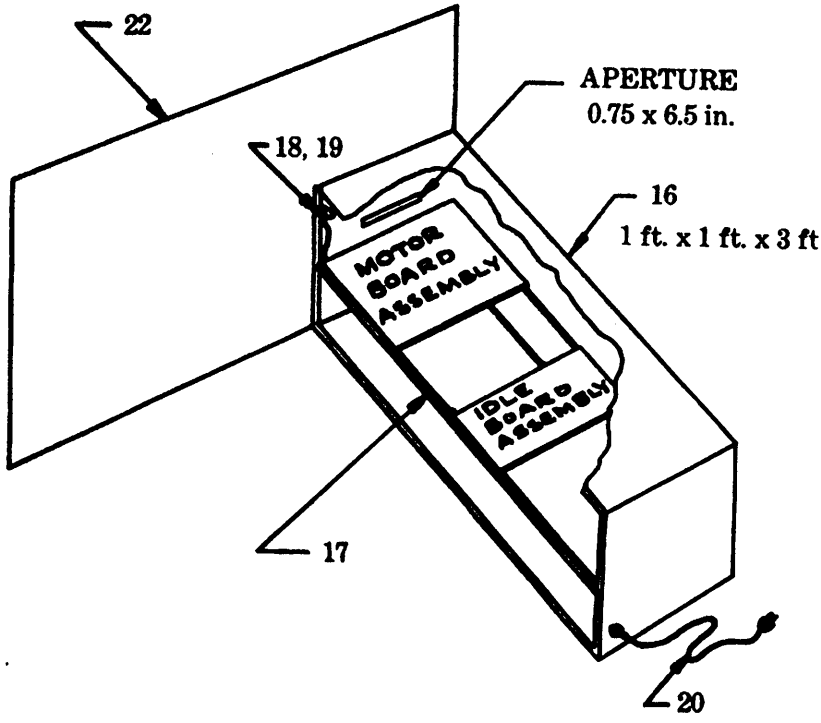

FIGURE 4. Housing Assembly

(See Table II for description of parts numbers)

TABLE II

Parts List

Part No.	Qty.	Name of Parts	Size	Material	Approximate Cost
1	1	Motor Board	11.75"x10"x3/8"	3 ply-plywood	.25
2	1	Motor	Dual Speed	See Text	16.00
3	1	Pulley	½" for ¼" shaft	Steel	.25
4	1	Drive Belt	3/16" Dia. 12" lng.	Leather	.05
5	1	Drive Wheel	4" Dia. 2" high	Ash	.09
6	2	Bracket	See Fig. 16	Aluminum	.10
7	2	Drum	2.9" Dia. 6½" long	Ash	.50
8	5	Bearing	3/16" Dia. hole	AN-310-24	.75
9	2	Shaft	3/16" Dia. 11¼" lng.	Steel	.10
10	26	Screw-wood	No. 4 7/8" long	Steel	.10
11	22	Screw-Mach. R.H.	6-32 3/4" long	Steel	.20
12	27	Nut-Hex.	6-32	Steel	.15

TABLE II (Cont'd)
Parts List

Part No.	Qty.	Name of Parts	Size	Material	Approximate Cost
13	14	Washer-Flat	3/16 Dia. hole	Steel	.05
14	1	Switch	3 amp.	Toggle	.30
15	1	Pointer	¼"x6"x.032	Aluminum	.05
16	1	Framework	1'x1'x3'	Aluminum	2.50
17	2	Runner	3/4"x3/4"x36"	Steel	.25
18	1	Socket-light	med. candelabra		.15
19	1	Bulb	7 watt candelabra		.10
20	1	Wire	No. 18 twin 10' lng.		.20
21	1	Panel	12"x12"x.064	Aluminum	.40
22	1	Shield	2'x3'x3/8"	3 ply-plywood	1.50
23	4	Screw-Mach. F.H.	No. 6-32 ½" long	Steel	.05
24	1	Idle Board	11.75x8"x3/8"	3 ply-plywood	.20
25	2	Bracket	See Fig. 1d	Aluminum	.20
26	2	Toggle Bolt	3/16"x2"	Steel	.10
27	2	Wing Nut	10"-24	Steel	.05
28	1	Spring-coil	1/16" Dia. 3 turns	Piano Wire	.05
				Total	$24.65

Fabrication of the components requires no unusual skill and the only finish required is for the front panel and the screen. Black wrinkle varnish is adequate. The aperture in the front panel is adapted to the tape in use by means of aluminum strips hinged and mounted to the rear of the panel.

To accommodate lists of less than 36 items it is necessary to repeat the list, and for 12, 6, 4, 3, 2, and 1 items the idle drum is not required. A pointer is provided within the apparatus which indicates by number the item which is being exposed in the aperture. Paired associates material may be presented either by the prompting method or by means of a shutter operated by microswitch relay controls on the driving wheel. Vinylite cement can be used to fasten the ends of the paper tape, which is of approximately index card weight. The tape is perforated to accommodate the driving pins on the periphery of the driving drum. A single list may be used with a drive on only one side of the tape.

Although a bit massive, the completed drum is durable, very quiet in operation, and possesses adequate physical control over some of the important independent variables of human learning experimentation. The total cost, *circa* $25.00 (summer, 1948) is considered reasonable.

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