

Cardboarding--

An integrated system to record, develop, test, index and file ideas.

Do not read this if you are in a hurry because:

It could change your attitude toward the creative phase of electronics.

Consistent application of several rules could change your way of life. The rules are valid whether your interest is vocational or advocational.

You will be induced into exploring the most obscure recesses of your mind.

The man that has not mastered his mind is the master of nothing.

If you do not have an hour to study now, put this aside until you are ready but, as a reminder write in the palm of your hand with a ball point pen the word—CARD-BOARD.

Cardboarding is a hybrid system developed from several ideas related to breadboarding.

The genesis of breadboarding is not clear. The term has earned a permanent place in the language of electronics.

Breadboarding is used to denote mock-up, dummy set-up, cut and try engineering, or any trial layout of a temporary nature. I have seen the term used in a paper on chemistry. A physicist told me that he had seen the term used in nuclear physics. This is understandable because the first cyclotron was a converted wireless arc transmitter from Palo Alto, California.

Early application of the term, breadboarding, was literal. Wireless components were fastened to a bread, or cutting board, to insure some physical stability and order. This method provided good access for alterations and maintenance. The flat layout on a single plane provided the designer with a bird's-eye view. A breadboard made it pos-

sible to establish a link between the abstract mental process and the concrete physical work. Oftentimes a breadboarded circuit became a permanent fixture. Large telegraph repeater stations would use huge mahogany or cherrywood tables, complemented by lacquered brass fittings, to mount the components for hundreds of telegraph channels. Some of these handsome components are conversation pieces in homes today.

I suspect breadboarding evolved from the old manual telegraph practice of mounting components on the operator's table top. As the station prospered, the tables were needed for other purposes. The components were rearranged on boards and fastened to the wall.

Various illustrations, of Alexander Graham Bell's development work on the telephone, have that breadboard look. Mr. Bell was trying to develop a multi-channel voice frequency telegraph system, nearly a century ago, when he observed a bit of phenomena that led directly to the development of the telephone.

Mr. Bell jotted down spontaneous ideas and observations on scraps of paper, on the backs of household bills or in a small notebook. A scribbled notation related to "undulating currents" is credited with winning the patent rights to the telephone. The notation was on the back of a household bill! This incident serves to emphasize the cardinal rule of cardboarding; Record the idea or observation now.

Breadboarding

The most ingenious, fastest breadboarding I have seen utilized 'glass-knob' thumbtacks. The components are equipped with pigtailed before mounting on the breadboard. The wire pigtailed terminate in small loops. Several pigtailed are thumbtacked together

on the breadboard to form a solderless tie point. Some of these boards look awful hairy but they are simple and easily constructed. The glass-knob thumbtack method is still practical for low frequency projects.

Commercial breadboard kits

To maintain a smooth stream of consciousness during the creative phase, breadboard designs were improved to permit the physical work keep pace with the mind. This important factor has produced a variety of systems. Several commercial kits furnish patch cords, plug-in components and special boards. The boards may be wood, plastic or metal. The more economical and simpler kits use perforated phenolic panels and special clip or spring connectors for a solderless tie point.

The makers of commercial boards emphasize saving time (speed), reusable components (economy), and structural visualization (spacial view). These systems do not integrate the schematic diagram to improve electrical visualization. Nor a means for recording, filing, indexing and duplicating the tests. The initial expense of the more elaborate kit is a disadvantage to economy minded experimenters. An elaborate kit, due to completeness, quality and flexibility is inherently costly. There are other features the experimenter may consider to be of greater importance. It is necessary to analyze the creative mind to illustrate that last statement.

The creative mind

All men are creative.

No race has a monopoly on invention.

All forms of mankind have contributed to the state of civilization that exists today. The ability to rationalize, to exercise logic and to project, are talents that distinguish mankind from animals. Another way of putting it; Man can prophesy. Current events seem to belie this, nevertheless, it is a fact. It is also true that mankind cannot predict every event in the future, however, the number of things mankind can predict exceeds the capacity to assimilate by any one man.

The creative talent varies among individuals. There are many factors that make up this talent. Some factors are inherited and others are the product of our environment. Most of these factors can be acquired

by self study and self discipline. Here is a list of the predominant ones; Motivation, Education, Opportunity, Reinforcement, and Serendipity.

Motivation: Motivation can be generated by the desire to serve and is the noblest of mankind's endeavors. The will to survive, which is inherent in all normal men. Curiosity will stimulate a man into doing all sorts of curious things. There are others not so noble but powerful such as prestige, power, money and greed.

Education: The sum of all your knowledge composed of experience, environment, academic or self-trained at least in the area of interest.

Opportunity: Opportunity is related and proportional to your education. The broadest education possible is the best insurance that you will be exposed to opportunities.

Curiosity: Curiosity is considered an inherent trait. This valuable trait can be developed and parallels education. Curiosity can lead you to bold original concepts.

Reinforcement: This factor is a concrete form of encouragement. A series of minor successes or rewards will sustain a man for many years on a single project. For the competitive man success, based solely on 'being a winner', will suffice to make him expend enormous amounts of energy.

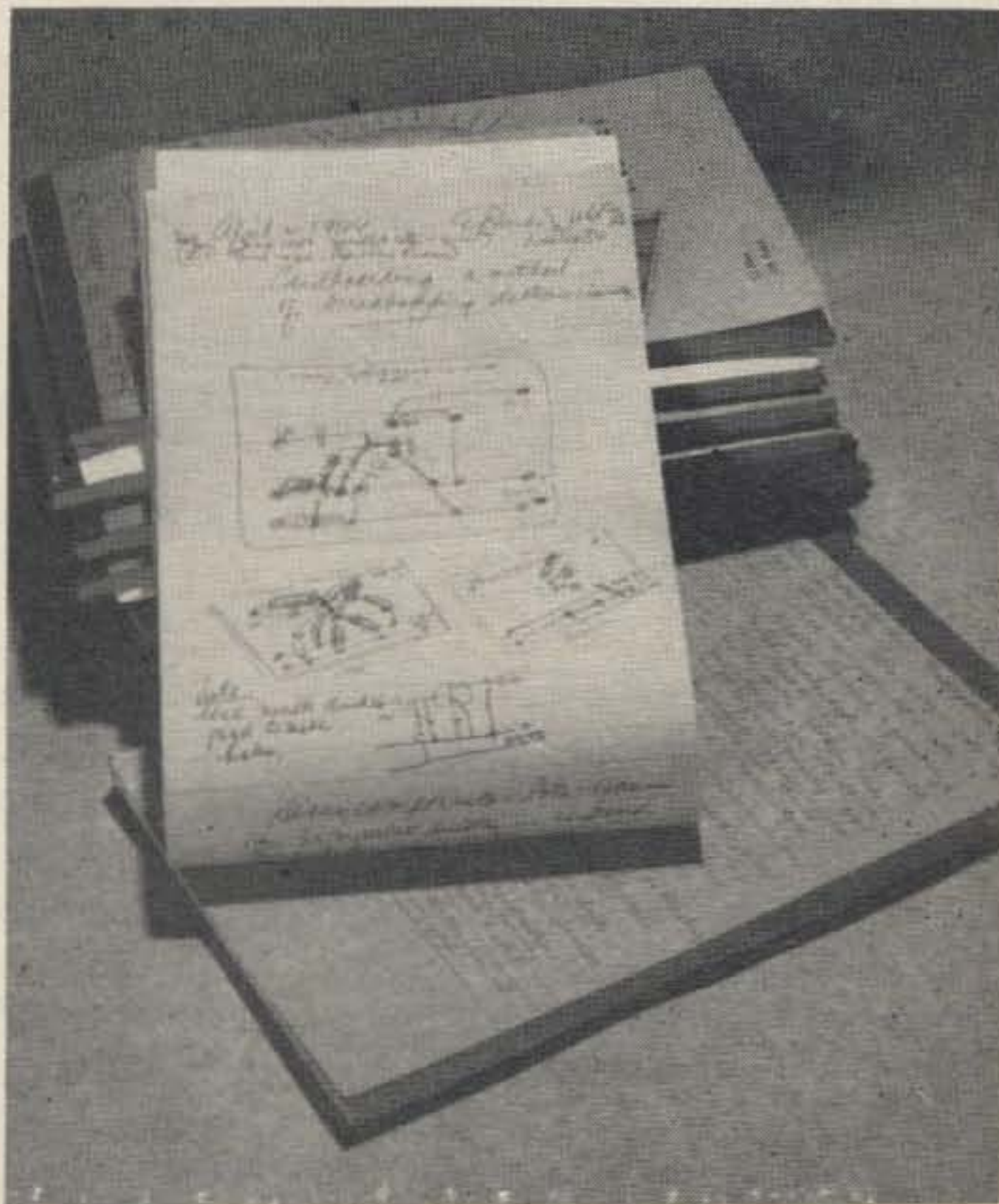


Photo 1. A cardinal rule is Record it NOW!

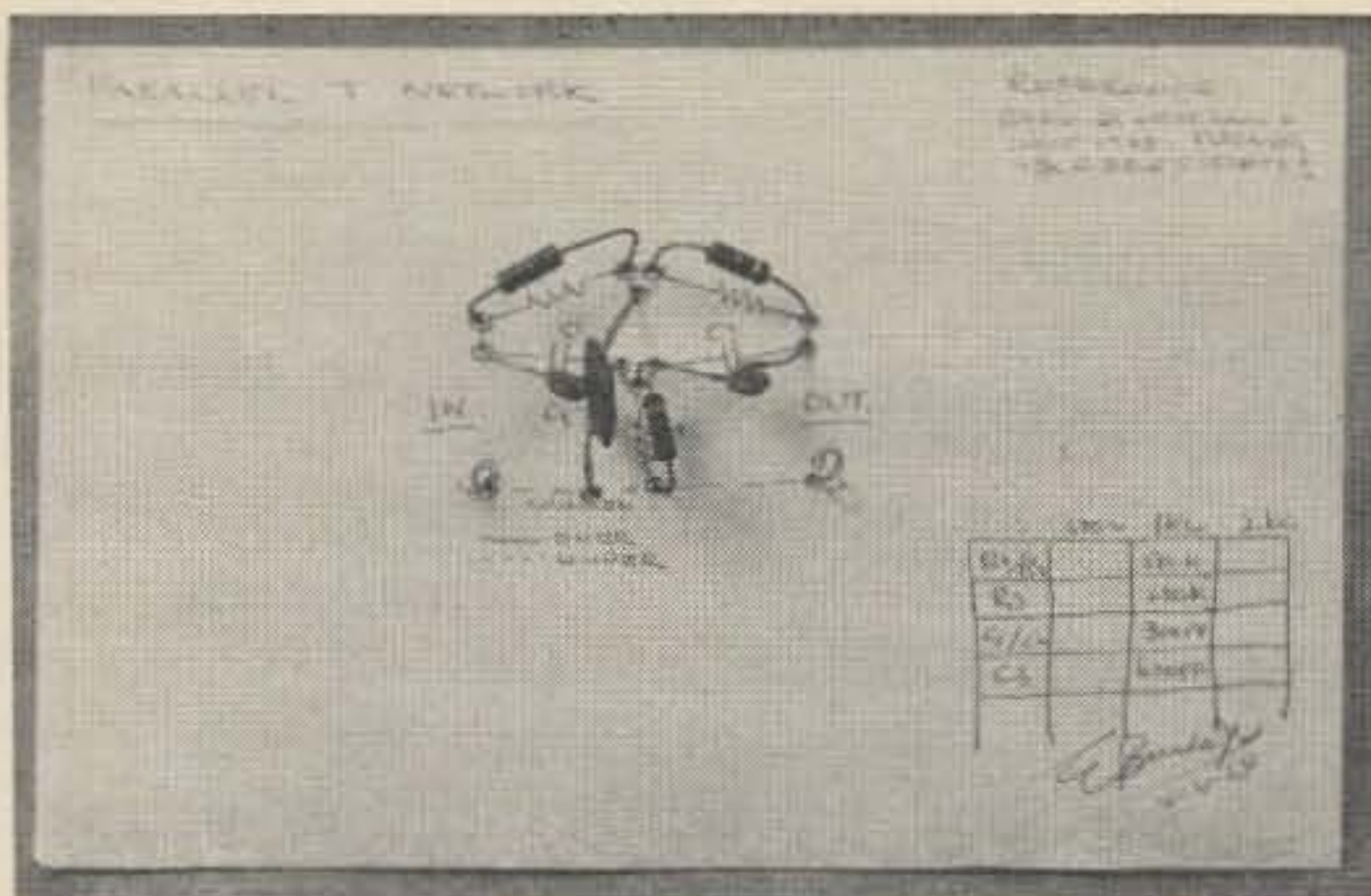


Photo 2. Groups of pinholes form tie points.

Serendipity: This is probably the least discussed but one of the most valuable traits a man can acquire. An artist would define serendipity in this manner; Use whatever means and materials you possess to create a thing of beauty. A prosaic man would simply state; Improvise.

Ideaphoria: This an obscure word rarely found in dictionaries. Ideaphoria is the rate or volume of creative ideas. The word is used in aptitude test results. A high ideaphoria indicates a highly creative imagination in the individual. In the context of this paper I am using the phrase 'creative mind' to connote high ideaphoria. The creative mind is a fulcrum upon whose sharp edge is balanced a man's sanity. Should his other talents be properly distributed he will be a prolific producer. He will be using all his talents and enjoying peace of mind. If the individual has not inherited or developed the other talents, he will become a paralyzed egomaniac who could destroy himself through utter frustration.

The preceding paragraph parallels my experience which led to the development of cardboarding.

The creative mind does not conveniently have single ideas.

The creative mind is boiling with ideas. It must improve everything it observes. Ideas pop out like olive pits. Most of these ideas are lost in the confusion and stress of the moment. The secret of capitalizing on the creative mind lies in some means for capturing these transients. These means must provide a favorable gestation period where the ideas can be selected or rejected in a stable environment. The resultant effect is to immobilize your ideas so that they may be examined and re-examined when the

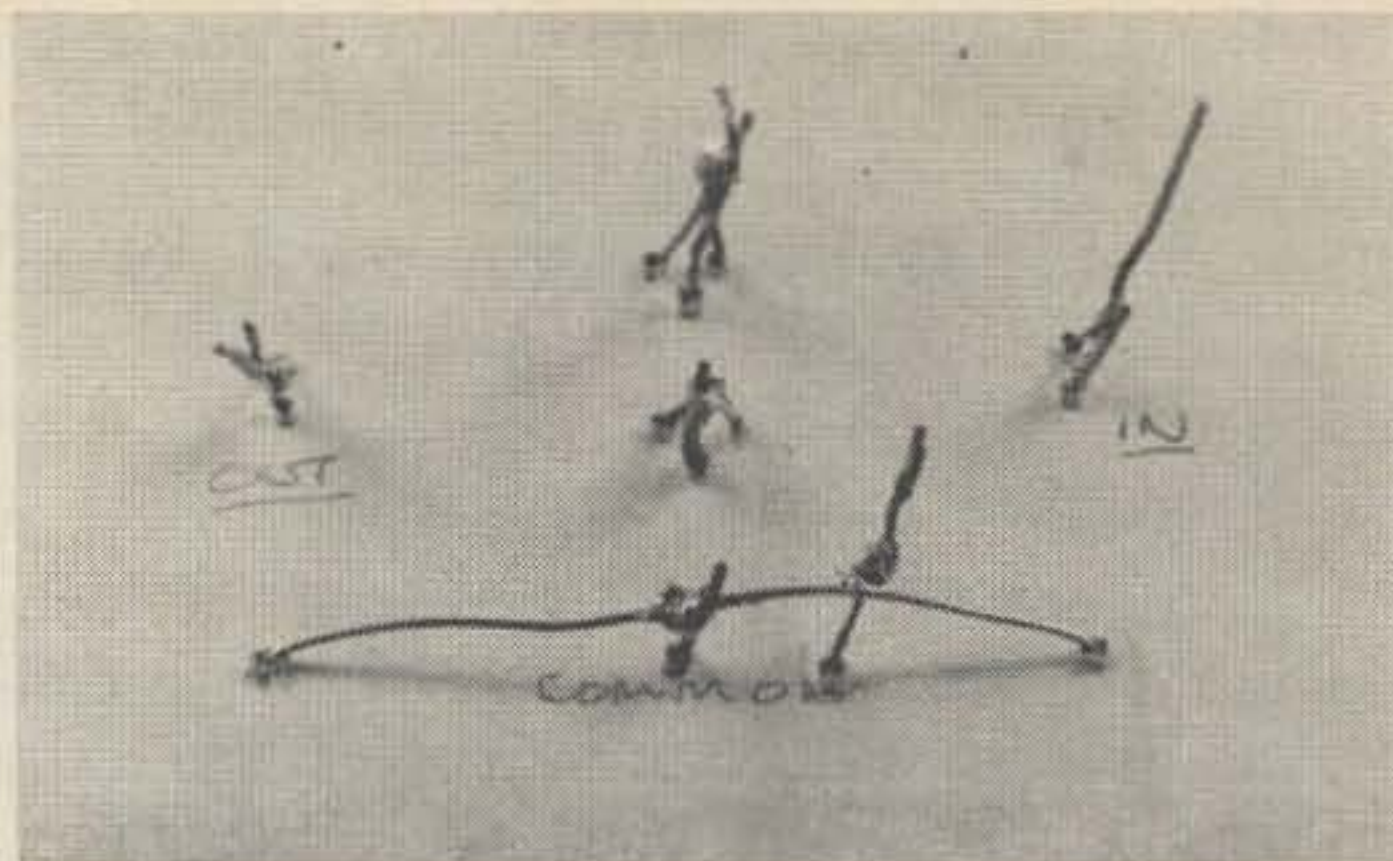


Photo 3. The pigtails are tacked together on the wiring side and lock the components to the cardboard.

time and the attitude is right. The creative mind is capable of exploring many projects concurrently, with a little help. This discussion on the creative mind has led us, full circle, back to breadboarding.

In order to accent more desirable features that should be incorporated in the breadboarding process, a lengthy digression on the creative mind was presented. At least one of these features should be obvious. Perhaps it will help if this rhetorical question is asked: Can you imagine how much money an experimenter would have to invest in a breadboard system that could handle a half dozen projects simultaneously?

The cardboarding system includes this feature, with considerable economy.

The great ones

Men who have contributed much to our technology and comfort were not men with one track minds. Study the biography of any one of these men; Franklin, Jefferson, Whitney, Tesla, Bell, Edison, deForest, Armstrong, Steinmetz and Lawrence. The names are usually identified with one great contribution. This great contribution was the pinnacle of their endeavors. It is a rare pinnacle with a broad base. All these men had creative minds, not one idea in one field but prolific in many fields. The key to their genius reveals itself, not in a formal textbook presentation, but in scribbled notes, crude sketches on scraps of paper and little dog-eared notebooks.

It is true, conception is rarely neat.

These great minds, the orderly scientist, the prolific inventor and the great innovators, how could they generate a shining image of order and enlightenment when all that

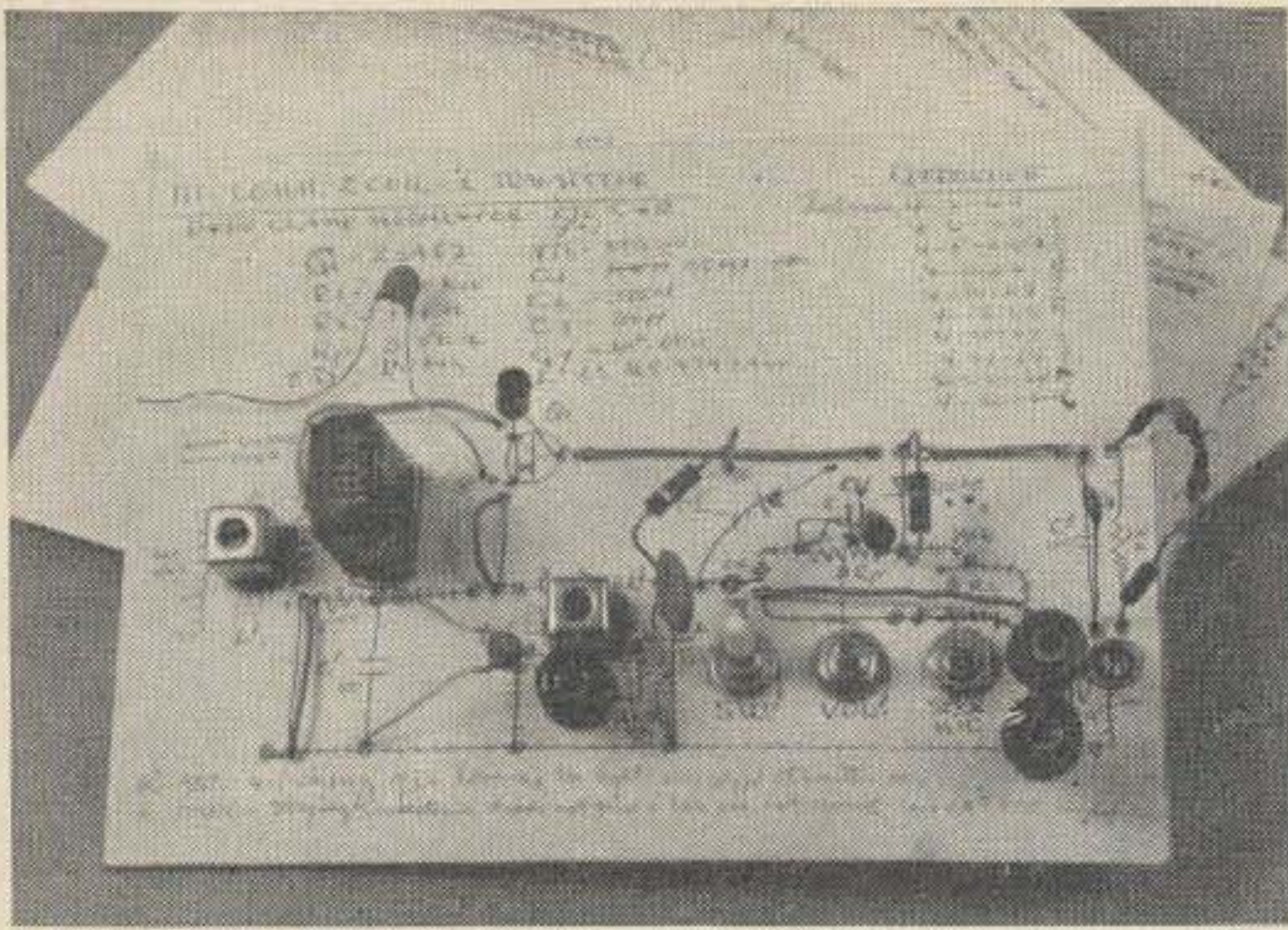


Photo 4. Jumpers interconnect the tie points either above or below.

can be found of the beginnings are scribbled notes and crude sketches? The answer to this question is the key to their genius.

Even though you scratch a word in the dust, it will be engraved forever in your memory.

Another way of putting it; It matters not the place nor time, nor why nor how. It does matter by rote or rhyme, record it now.

The cardboarding system

The cardboard feature of this system was one of many ideas recorded over a decade. The cardboard idea became the catalyst that bound several related ideas together to form an integrated system.

Cardboarding begins when you record the idea. (Photo 1) The cardboard feature parallels the stream of consciousness during the development and testing phase. The system provides a record of progress and summaries. A method for filing the cardboard is provided. The information is crossindexed, retrievable and reproducible on the original cardboard. This list and illustrations explain each step applied in sequence.

1. Recording the idea:

The transient idea must be recorded immediately. This requires an ordinary pencil tablet (10c). The 5½x9 inch size with the least number of pages will insure that enough room is available on the back cover for indexing. Over a period of years the number of tablets you fill with ideas will amaze you. Use the most available to maintain some uniformity for storage. The front cover should carry the date of the first entry, when the last entry is made add it to the front cover. These two dates will give you random access to the correct notebook.

A clean page is devoted to the idea, no matter how incomplete the idea may be. A simple basic drawing and explanation is sufficient. The date, title or keyword and your signature is recorded at top of page. These items are then entered on the back cover, and is the beginning of the chronological index to provide random access to contents of the notebook. Subsequent entries are made chronologically on clean pages, the date and title is followed by word or words keyed to the change or modification. This is also transferred to the back cover.

When a cardboard is started: The original date, title from your notebook and signature is placed near the top edge. The starting date of the physical work on the cardboard is added on the date you actually begin. In some other area, either front or back, of the cardboard enter all previous and subsequent dates and keywords in chronological order. Include source or reference articles from books and magazines. As development progresses, continue recording on clean pages of notebook, index cover and the chronological list on the cardboard. This description appears to be complex. In practice it is simple because it follows a natural flow of activity and is a chronicle of that activity. If you adhere to this discipline, you will have a cross-indexed record that is nearly fool proof. Experience has revealed that time spent on records is small compared to the time spent on the whole project.

2. Cardboarding the idea:

(a) Cardboard stock—ordinary file cards are too light for all but the simplest circuits. Posterboard will handle everything except the heaviest components such as large power transformers. Posterboard is supplied in 22"X28" stock by stationary and art supply stores.

(b) Cutting stock—household scissors will cut the heaviest stock you will ever use. Illustrations show 5"X8" cards of various weights. Think small, 3"X5" think big, 8½"X11".

(c) Schematic drawing—arrange components so the drawing will form groups of tie points and still maintain a readable schematic. (Photo 2) The tie points are a group of several pin-holes. They are spaced about ⅜" apart. This allows the pigtailed wires to pass through the cardboard separately to merge underneath or wiring side.

The ends are tacked together with solder. This method provides a locking feature for small self supporting components such as resistors, capacitors, transistors and diodes. A jumper wire on either side of cardboard can interconnect tie points. The schematic will be easier to read if components are properly spaced. Study photos 3 and 4. A simple bridged-T filter pad requires a minimum of interconnecting jumpers. The other extreme is illustrated by a cardboard of shielded inductors, switches, jack, potentiometer, crystal holder and transistor. Fortunately the components tend to stiffen the cardboard.

(d) Making the holes—Pinholes are made by a needle-chuck test prod. The larger holes, $\frac{3}{8}$ " to $\frac{5}{16}$ ", are made by burning, with a modified Ungar type burning kit. Woodburning kits are available in toy or hobby shops. The largest tip is stepped down to four sizes by a small lathe or by chucking in an electric drill. (Photo 6.) The electric drill is clamped in a vise. The tip is filed down while the drill is running. Diameters between steps is not so important as maintaining a square shoulder between between steps. A flat face at each step will insure clean holes. Holes may be enlarged by wiping hot tip around inside of hole. (Photo 5). Extremely large holes are made by chassis punches. Burn holes can be cleaned with an old toothbrush. A small jar, with $\frac{3}{4}$ " hole in lid, is an anvil. The cardboard is placed over hole of anvil for punching or burning. Anvil will catch any debris from burning and brushing. All the tools are stored in the filebox. Photo 7 of the file box shows all tools used in the cardboarding system.

(e) Recording changes: As development progresses record important modifications in the notebook with suitable index on back

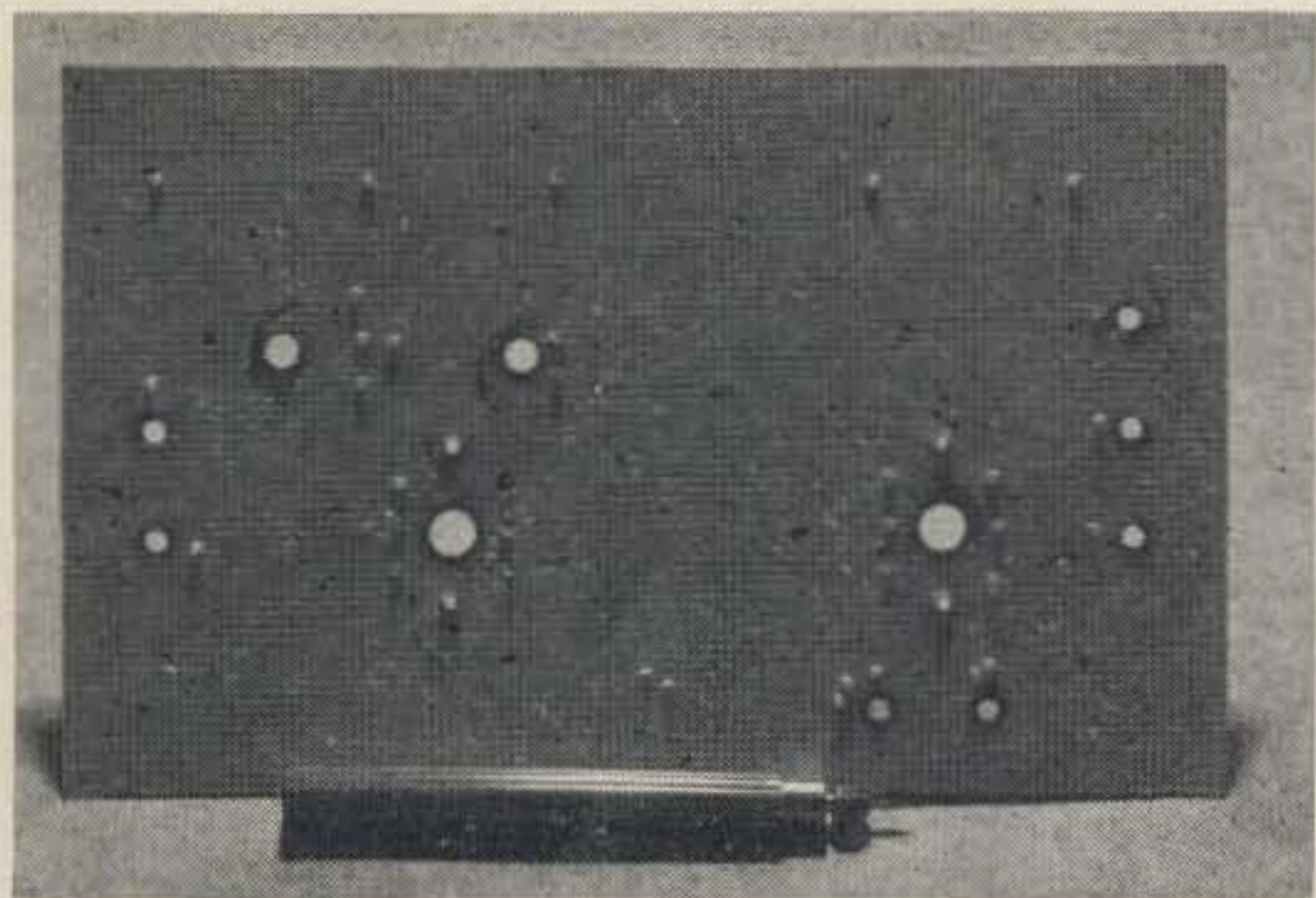


Photo 5. The large holes are burned in.

cover. The date and keyword is added to cardboard to maintain cross-index feature. When you reach a stage of development where you want to record progress, summarize in the notebook, and complete the cross-indexing routine again.

(f) Termination of development: When the project has been explored to a point where no further progress is anticipated, or development work is complete, the components are removed from cardboard and put back into stock. The final entry in the notebook should be summary with appropriate conclusions. The cross indexing procedure is applied to cover and cardboard again, before filing the cardboard.

3. Filing the cardboards:

File boxes are available in several colors, materials and sizes. Prices vary from 50c to several dollars. The file box shown in the photograph is 5"X8", of metal and finished light gray. It has a full length piano hinge and is of excellent quality. The retail price with indexed separators is less than two dollars. The boxes found in variety stores are of lesser quality and retail for less than a dollar. The larger boxes, 8 $\frac{1}{2}$ "X11", complete with separators and lock can be bought for less than two dollars. The use of an appropriate title for the project simplifies filing and access. If you can remember only one date of several that relate to the project, or the title of project, you can recover all the information on the project in a few moments.

4. Conclusion:

To insure successful operation of this system these rules must be practiced religiously;

(a) Get that spark of inspiration recorded, even though you write on the palm of your hand with a ball point pen!

(b) Paradoxically, the act of writing improves your memory.

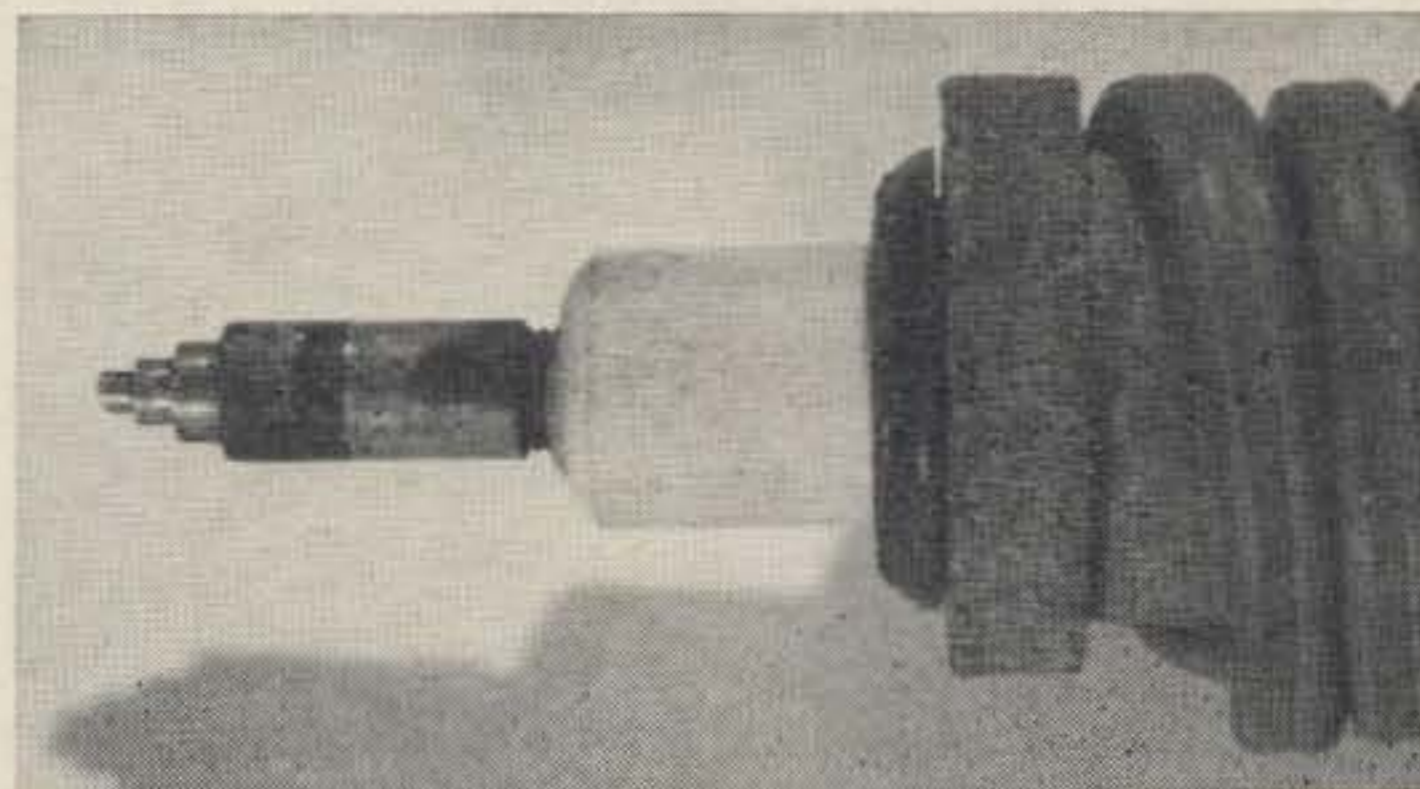


Photo 6. Maintain a flat face at each step on the modified tip.