



## Applied Science Center for Archaeology

THE UNIVERSITY MUSEUM • UNIVERSITY OF PENNSYLVANIA  
 33rd & SPRUCE STREETS • PHILADELPHIA 4, PENNSYLVANIA  
 Froelich Rainey, Director EVergreen 6-7400 (Area code 215)  
 Elizabeth K. Ralph, Associate Director  
 EVergreen 6-0100 Ext. 8168 (Area code 215)  
 Cable Address "Antique"

If we work in a field where there are high weeds, then we have an extra workman to coil and uncoil the cables as we move along.

In the long run, I'm wondering if lead acid batteries of the type that I brought, but smaller wouldn't be better. Yours weigh 8 kilograms and have a capacity of 7.5 ampere-hours maximum. Mine weigh ~~32~~ <sup>25 kg without case</sup> kilograms and have a capacity of 25 ampere-hours. If we could find ones that weigh  $\frac{1}{3}$  or  $\frac{1}{2}$  as much, we'd have the equivalent, if not more, capacity for the same weight. If they are slightly larger, that is of no importance because they could be carried in a knapsack just as easily. The other big advantage is that (by means of a switch from series to parallel) they can be charged with any simple 6 volt charger - that can be found or carried almost anywhere in the world. Now that the cesium magnetometer itself is extremely portable, the next problem is to reduce the requisite subsidiary equipment to a minimum so that one can move from site to site or country to country by air. With the Ni-Cd batteries, the battery charger weighs as much as a complete instrument. My lead-acid batteries are Terra-Scout TS-BA6 (\$30.00 each) made, I think, by Soltrest in Evanston, Illinois. Perhaps, they could make some smaller ones. The 3 little balls that tell about the condition of charge and specific gravity are also a great help abroad where you don't have all of the laboratory equipment. I realize that lead-acid is quasi-obsolete, but they do seem to be the best when current drains approach 1 ampere.

Our drilling program confirmed most of our anomalies except for a region closer to the coastline. There, we seem to have found strange pockets of clay instead of archaeological features.

With best regards to all,  
 Beth

5/11/60

ADDITIONAL INSTRUCTIONS FOR MICHIMHO MODEL 274 M

I. BATTERIES

A. Description

The 2 batteries (Burgess 4PH,  $1\frac{1}{2}$  volts each) supplied originally with the instrument have been replaced by 3 Nickel Cadmium Alkaline Storage Cells, 1.25 volts each (obtained from Esse Radio Co., 42 W. South St., Indianapolis 25, Ind. @ \$2.95 each). See battery description sheet for detailed battery information.

In the instrument, 3 cells are connected in series and a fourth is mounted with them as a spare. The cells have a capacity of approximately 10 ampere hours which is equivalent to 3 hours of continuous instrument operation (average current drain is approximately 3 amps). If the instrument is operated for 15 seconds for each reading, this is equivalent to 720 recordings.

B. Battery Charging

1. Put instrument near automobile battery with handle side up.
2. Plug cord into socket labelled "charge".
3. Connect clips across two cells (4 volts) of automobile battery.  
Black is minus and red, plus.
4. Allow Ni-Cd cells to be charged for 20 minutes (not more than 30 minutes).
5. Disconnect clips.

When charged and after standing a few hours, the solution level in the cells should be above the red lines. If not, add distilled water. If the instrument works after 20-30 minutes of charging, there is probably no need to open the case to look at the solution level.

The current drain on the automobile batteries is expected to be negligible.

II. SPARE PARTS

A. Extra set of NI-Cd cells (Connect only 3 in series).

B. Vibrator, Oak Mfg. Co., Chicago, Ill., No. 453428.

If batteries are all right and vibrator doesn't operate, plug in new one-replacement for the one in instrument labelled Ex 3428.

C. Calibration resistors and wire.

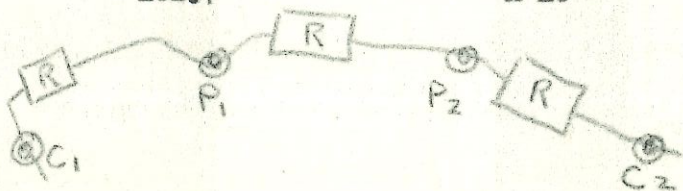
D. Lead repair tools -- soldering iron, wire cutters, longnose pliers, solder, screw driver. Trouble Lite.

E. Old Burgess batteries and bracket.

III. CALIBRATION CHECK

Connect bare wire, set of three 3 ohm resistors, set of three 10 ohm resistors, or set of ~~3-100~~ three 100 ohm resistors for various scales as shown, and take readings.

Item Connected	Actual Resistance	Scale	Reading (5/11/60)
Bare wire	0	x 10	∞
3 x 3	<del>3.3037</del> 3.037	x 10 <sup>-1</sup>	<del>10</del> 3.39
3 x 3	4 3.037	x 10 <sup>-2</sup>	33
3 x <del>9.981</del> 10	9.981	x 10 <sup>-2</sup>	10
3 x 10	9.981	x 10 <sup>-3</sup>	90
3 x 100	101.7	x 10 <sup>-3</sup>	9.7
3 x 100	101.7	x 10 <sup>-4</sup>	85



← resistor connections

Note: "Reading" values, i.e., calibration of the instrument is not perfect, but this should not be a serious handicap for comparative readings.

IV. LEAD CHECK

If a broken lead is suspected, connect leads, one by one, across automobile battery with "Trouble Lite" in series. If light doesn't go on, lead is open. Repair lead with tools supplied.

**NICAD**

# NICAD DIVISION

GOULD-NATIONAL BATTERIES, Inc.

7 DEY STREET, PHONE: CORtlandt 7-2515

*New York 7, New York*

November 28, 1961

University of Pennsylvania  
Philadelphia 4  
Pennsylvania

Attention: Mrs. Elizabeth K. Ralph

Dear Mrs. Ralph:

You have recently requested information on our rechargeable nickel-cadmium batteries and we wish to assure you that your interest in our products is genuinely appreciated. If you require further data at any time, please do not hesitate to contact this office for engineering or application assistance.

Very truly yours,

Nicad Division  
Gould-National Batteries, Inc.

*Lewis Hofstatter*  
p.d.

Lewis A. Hofstatter  
Eastern Regional Manager

LAH/pd

5360, 4.5 v  
1.5 AH, 4 cells  
4.8V/450C # 1.50/cell  
2 1/2  
- dimensions

December 6, 1961

Mr. Lewis A. Hofstatter  
Nicad Division  
Gould-National Batteries, Inc.  
7 Dey Street,  
New York 7, N. Y.

Dear Mr. Hofstatter:

Thank you for your letter of November 28th and for some information about Nicad batteries. The latter doesn't quite answer my immediate questions.

First of all, the spaces in our present instruments are suitable to hold rectangular batteries, so don't bother to send more about cylindrical and button types.

One immediate application is to find a sealed rechargeable battery as a replacement for Burgess No. 4FH (actually, for two connected in series). Therefore, what are the dimensions of Types P1.5, P2.0, P3.5, SP4.0, P4.5, P6.0, SP7.0, P7.5, P4, P15, P19, P23, or a more suitable one that you might suggest?

In another instrument, we want to replace storage cells, which presently add up to 12 volts, with batteries which remain sealed when transported by air, etc.

Do you manufacture one similar to 6.0V/P1.5 with greater ampere hour capacity, and what are its dimensions? Would you also please send me the ratings, dimensions, and costs of Nicad Sintered Plate Storage Batteries. I received nice pictures of these (Bulletin 501), but no specific data.

These instruments are for use in archaeological prospecting and will be taken to remote places where there is no electricity. Can you supply any information in regard to charging Nicad batteries from 6 or 12v automobile batteries?

Sincerely yours,

Elizabeth K. Ralph  
Research Associate

EKR/deh

10.65 per cell  
5-6 lbs.  
x 3 28.203.00  
P-11 11 AH  
sealed  
cell  
4.0 SC  
2 x 6V 8AH  
4.0 SC  
2.300

**NICAD**

# NICAD DIVISION

GOULD-NATIONAL BATTERIES, Inc.

7 DEY STREET, PHONE: COllandI 7-2515

*New York 7, New York*

January 17, 1962

University of Pennsylvania  
Department of Physics  
Philadelphia 4, Pennsylvania

Attention: Miss Elizabeth K. Ralph  
Research Associate

Dear Miss Ralph:

This is simply to inform you that your reply to my last letter will require such lengthy and involved answers that I think it would be better if I called you early next week and reviewed the situation verbally first. I will subsequently be in a better position to offer you a comprehensive formal quotation on whatever items we decide upon.

Naturally, your interest in our products is genuinely appreciated and we look forward to supplying you with what are internationally recognized as the world's finest and most reliable batteries.

Very truly yours,

Nicad Division  
Gould-National Batteries, Inc.

*Lewis A. Hofstatter*

Lewis A. Hofstatter  
Eastern Regional Manager

LAH/pd

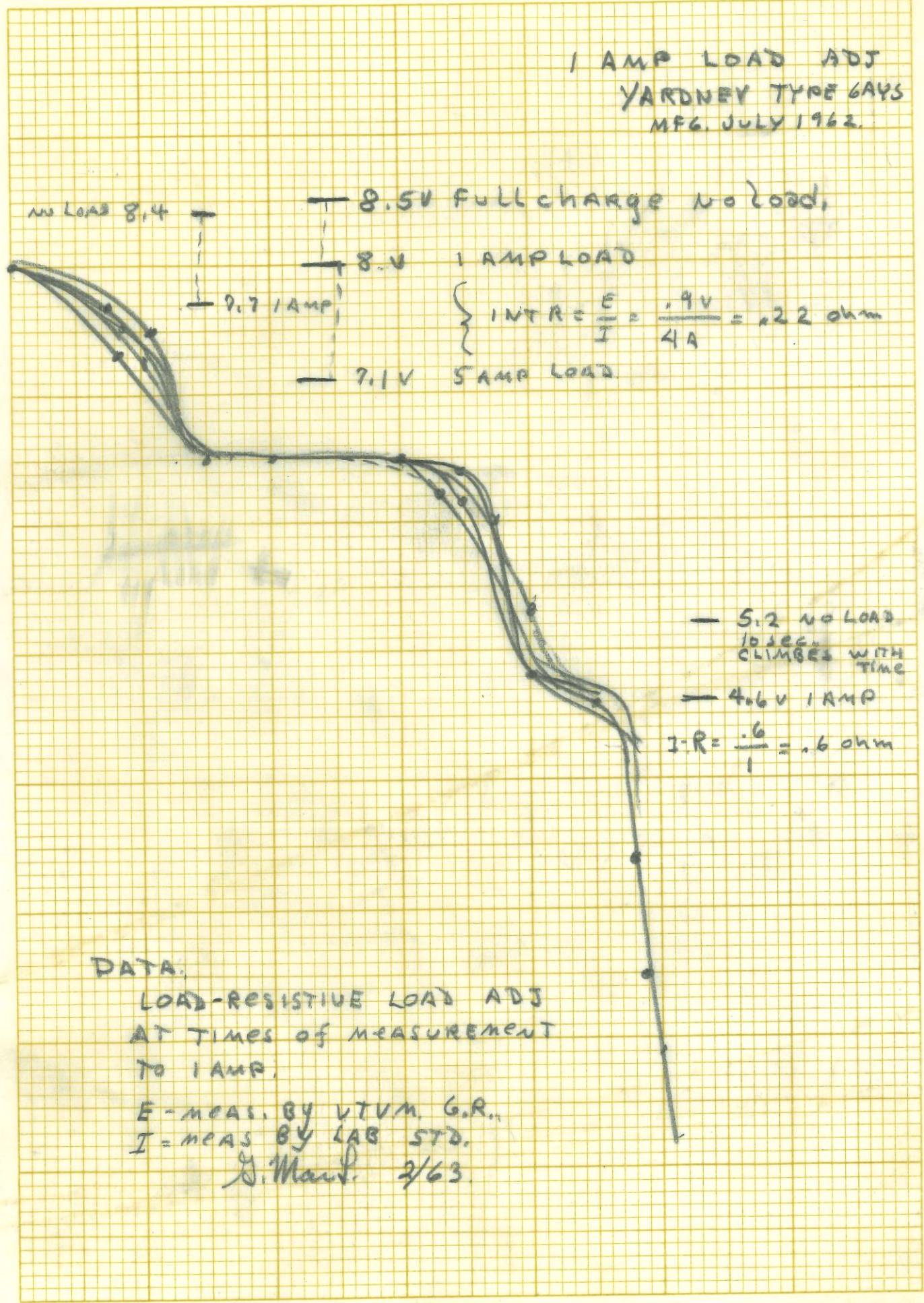
1 AMP LOAD ADJ  
YARDNEY TYPE 6AYS  
MFG. JULY 1962.

EUGENE DIETZGEN CO.  
MADE IN U.S.A.

NO. 340A 1:10 DIETZGEN GRAPH PAPER  
10 X 10 PER INCH

VOLTS

VOLT 54



DATA:  
LOAD-RESISTIVE LOAD ADJ  
AT TIMES OF MEASUREMENT  
TO 1 AMP.

E-MEAS. BY VTVM, G.R.  
I-MEAS BY LAB STD.  
J. Mant. 3/63.

HOURS

February 19, 1964

Mr. Robert H. Riley, Jr.  
Development Manager  
The Black & Decker Mfg. Co.  
Towson 4, Maryland

Dear Mr. Riley:

A year or so has elapsed since we purchased some Black and Decker Industrial Power Packs, Cat. No. 51800 and 51900, following your visit with Mr. Clark to our ASCA labs. I had hoped to have more to report about the use of these in our various instruments, but, unfortunately, we are still designing and assembling most of them.

We did give one battery a few cycles with a 1 amp load and the plot of this test is enclosed. Another battery, we are using as a power source for a sonic transducer. This unit draws from 0.5 to 0.75 amps for intermittent periods of approximately 1 minute each. Since the field tests of this are being conducted in Texas, I don't have a complete report of the battery behavior at this time.

We are having some trouble with one of the 9 volt batteries (cat. no. 51900) in our 1/2-inch drill. We have used the drill intermittently, approximately 8 hours total and have charged the batteries (very little required) each time before use. We have not, however, used the drill nor charged it since September, 1963. We find now that one battery is corroded at one end, has practically no voltage, and when we tried to charge it, it soon became hot and seems to have damaged the charger (cat. no. 949, type A).

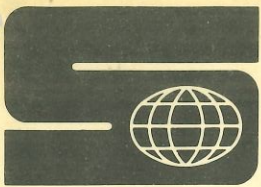
I am sending both the battery and the charger to you, and am sorry to trouble you with this problem. If a purchase order is necessary for the cost of repairs, please let me know.

Sincerely yours,

E. K. Ralph

EKR/deh

Encl.



# SOILTEST, INC.

2205 LEE STREET  
EVANSTON, ILL. 60202, U.S.A

QUOTATION

No. **32192**

SUBSIDIARY OF CENCO INSTRUMENTS CORPORATION. TELEPHONE 312/869-5500, CABLE SOILTEST EVANSTON

TO: University Museum  
33rd and Spruce Sts  
Philadelphia, Pennsylvania  
  
Attn: Miss E. Ralph

DATE August 23, 1965  
YOUR INQUIRY Telephone  
DATED August 23, 1965

GENTLEMEN:

WE SINCERELY APPRECIATE YOUR INQUIRY AS NOTED ABOVE AND ARE PLEASED TO QUOTE AS FOLLOWS:

These Prices  F.O.B. Soiltest Factory  
Are:

Terms:  Net 30 Days.  Payment with order.

Export, confirmed irrevocable letter of credit payable through Chicago or New York Bank.

SOILTEST, INC.  
*E.E. Brush*  
BY Edward E. Brush  
TITLE Vice-President

THIS QUOTATION IS FIRM FOR A PERIOD OF 30 DAYS

XXXXXXXXXXXXXXXXXXXXX  
SUBJECT TO CREDIT APPROVAL

ITEM NO.	QUANTITY	MODEL NUMBER	DESCRIPTION	DELIVERY	UNIT PRICE	TOTAL
1	5	#TS-BA6	Battery, 6 volt, complete with terminals  Battery Dimensions: 6" high x 7" wide x 3-3/8" deep  <u>NOTE:</u> The Battery Charger used in the Model R -150, Terra-Scout incorporates the wiring system of the unit and therefore cannot be supplied separately. It is recommended that you obtain a standard 6 volt battery charger from your local auto accessory supply store.	Stock	30.00	\$150.00

*4-5 lbs each*

*Ordered 8/24/65*

cc: SOILTEST, Inc.  
237 Sheffield Street  
Mountainside, New Jersey

sa

December 30, 1965

Willard Battery,  
P.O. Box 6949  
Cleveland, Ohio.

Att'n: Sales Engineering Dept.

Dear Sirs:

For use with a portable magnetometer, I am looking for lead-acid batteries smaller than those which you manufacture for Terra-Scout, type TS-BA6 with 25 ampere-hour capacity.

Do you or could you manufacture this same type with 8 ampere hour capacity (6 volts) and hopefully weighing one-third as much?

Sincerely yours,

Elizabeth K. Ralph

EKR:LF



*Wrote for costs  
& delivery forms  
1/18/66*

2000 EAST OHIO BLDG. • P. O. BOX 6949 • CLEVELAND, OHIO • 44101

January 7, 1966

Miss Elizabeth K. Ralph  
University Museum  
University of Pennsylvania  
33rd and Spruce Streets  
Philadelphia 4, Pennsylvania

Dear Madam:

In response to your letter dated December 30, 1965, enclosed is our catalog MC-800 listing ESB Brands Special Purpose Batteries.

You will find on page 4 of this catalog a listing of ER type plastic cells and 6 volt batteries. Should any of these appear to interest you as suitable to your application, it is then advised that you contact our Wisco Division for additional information and costs.

Wisco Division  
The Electric Storage Battery Co.  
1222 - 18th Street  
Racine, Wisconsin

PHONE: MELrose 2-2771  
Area code: 414

Thank you for your consideration in writing to us for information.

Yours very truly,

ESB BRANDS, INC.

*Frank L. Huttlin*  
Frank L. Huttlin  
National Service Manager

FLH:jpp

Enclosure



DIVISION — THE ELECTRIC STORAGE BATTERY CO.

MAIN OFFICE AND PLANT

1222 18th STREET · RACINE, WIS., 53403 · 414-632-2771



January 21, 1966

Applied Science Center for Archaeology  
The University Museum  
University of Pennsylvania  
33rd & Spruce Streets  
Philadelphia 4, Pennsylvania

Attention: Elizabeth K. Ralph

Gentlemen:

We are pleased to quote you on the batteries mentioned in your letter of January 18, 1966:

<u>Type</u>	<u>Price Each</u>	<u>Delivery</u>
ER-6-6	\$15.84	Stock
ER-6-6B	15.60	Stock
ERS-10-6	21.96	10 Days

Quantity 1 to 9 batteries.  
Dry charged batteries--acid not included.  
f.o.b. Racine, Wisconsin.  
Terms Net 30 Days.

Thank you for your inquiry and interest in our products.

Very truly yours,

WISCO DIVISION

*G. W. Linn*  
G. W. Linn  
General Manager

GWL:kb

15.84  
5  
79.20

February 18, 1966

Attn: Mr. G. W. Linn  
Wisco Division  
The Electric Storage Battery Co.  
1222 18th Street  
Racine, Wisconsin 53403

Dear Mr. Linn:

Please add one more battery to Museum (University of Pennsylvania) Purchase Order Number 75192.

This changes the order from 5 to 6 ESB Portable Batteries.

Sincerely yours,

Elizabeth K. Ralph

EKR:mhr

October 6, 1966

✓ Battery Research Division  
Gulton Industries, Inc.  
Metuchen, N.J.

Dear Sirs:

In the N.Y. Times this morning, I read with interest about the new lithium batteries that you are developing.

Our interest in batteries is for use in portable instruments for archeological prospecting--maximum wattage for the smallest amount of weight and bulk. If there is any possibility that your new batteries would be suitable for this purpose, I should appreciate it very much if you could send me more information about them.

Sincerely yours,

Elizabeth K. Ralph

*Ford Motor Company*

SCIENTIFIC RESEARCH STAFF

20000 ROTUNDA DRIVE  
P. O. BOX 2053  
DEARBORN, MICHIGAN 48121

October 17, 1966

Miss Elizabeth K. Ralph  
Associate Director  
Museum Applied Science Center  
for Archaeology  
University of Pennsylvania  
33rd & Spruce Streets  
Philadelphia, Pa. 19104

Dear Miss Ralph:

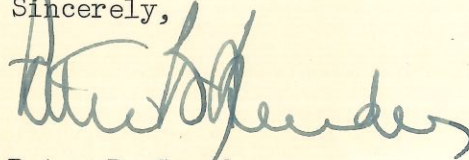
This is to acknowledge and thank you for your letter of October 4 regarding our new sodium-sulfur battery.

Development of this battery is still in the laboratory stages and we anticipate it will be at least a year before prototypes will be ready for testing in a vehicle.

At this time, we have no plans to make this battery available commercially.

Your interest in the activities of Scientific Research Staff is greatly appreciated.

Sincerely,



Peter B. Spender  
Public Relations Manager



*Pioneers in materials research, electronic components,  
precision instruments, and systems engineering*

**Gulton Industries, Inc.**  
Alkaline Battery Division

212 Durham Avenue, Metuchen, New Jersey 08840 • Tel. (Code 201) 548-2800

December 15, 1966

Miss Elizabeth K. Ralph, Associate Director  
MUSEUM APPLIED SCIENCE CENTER FOR ARCHAEOLOGY  
UNIVERSITY OF PENNSYLVANIA  
33rd and Spruce Streets  
Philadelphia, Pennsylvania 19104

Gentlemen:

Thank you for your interest in our lithium battery which was recently described in connection with the power source for electric cars.

The lithium nickel-halide battery represents a potential high energy density source of electric power. At present, it has reached the stage of development where laboratory experimental models in sizes up to 20 ampere hours have been built and tested successfully. This work has been reported in scientific and engineering journals, and there is attached an abstracted brief of some of the technical work along with our press release and some photographs of the 20 ampere hour cell.

With a concerted engineering development, this battery could become a fully developed product - probably within a year.

At the present time, there are no standard models available and, hence, no price or delivery structure exists.

As soon as the product is made commercially available, we will send you our product sheet with a full description of available sizes.

We believe that the lithium battery could become a significant system, and your interest in this development is appreciated.

Very truly yours,

GULTON INDUSTRIES, INC.

*William E. Ryder*

William E. Ryder  
Applications Manager  
Alkaline Battery Division

WER/b1  
Encl.

August 28, 1968

Battery Application Sales &  
Engineering Department  
Consumer Products Division  
Union Carbide Corporation  
270 Park Avenue  
New York, New York 10017

Dear Sirs:

Please send me information including cost, duty-life, shelf-life, and availability of "Eveready" batteries type NP8-6/T, 6v, 8 AH.

One of our applications will require two in series to provide 12 volts to power a proton magnetometer. It is more convenient to charge them also in series and I should like to know if you manufacture a charger of this type. I have a copy of your form R-2256, but I imagine that the charger for battery NP1-12/T is not suitable.

Sincerely yours,

Elizabeth K. Ralph

EKR/mhr

April 15, 1970

Manager, Battery Engineering  
Union Carbide Corporation  
Consumer Products Division  
270 Park Avenue  
New York, N. Y. 10017

Dear Sir:

Could you please let me know what <sup>are</sup> the ampere-hour ratings of the following three types of Eveready batteries:

No. 703	,	4 1/2 volts
No. E9	,	1 1/2 "
No. 915	,	1 1/2 "

Thank you in advance.

Sincerely yours,

R/rs

Elizabeth K. Ralph

April 15, 1970

Burgess Battery Company  
Freeport, Illinois 61032

Dear Sirs:

Could you please tell me what are the ampere-hour ratings of the following three types of Burgess batteries:

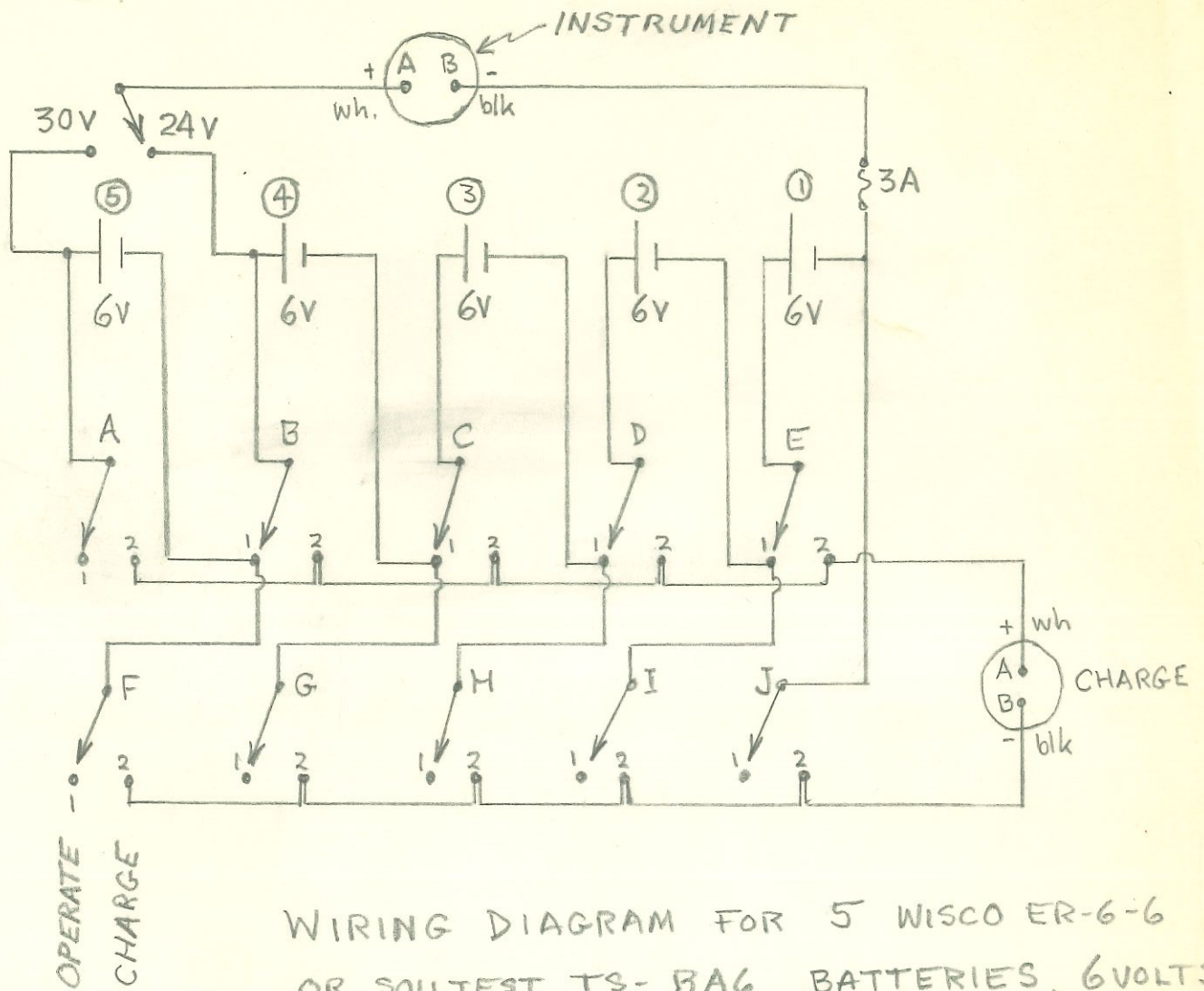
No. 532	,	4 1/2 volt
No. Hg-9	,	1.5 volts
AA cells	-	same size as Hg-9, but without mercury.

Thank you in advance.

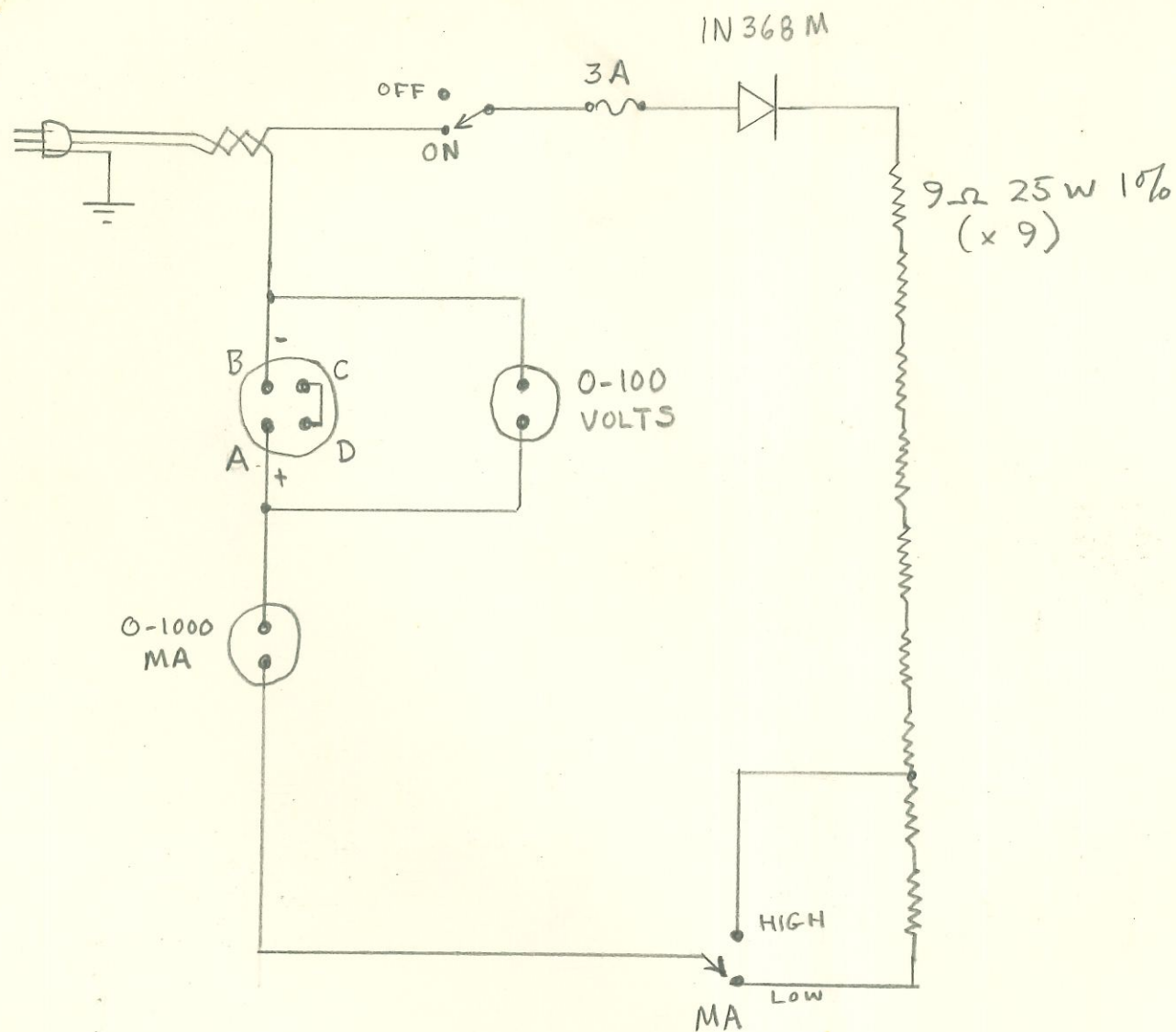
Sincerely yours,

R/rs

Elizabeth K. Ralph



WIRING DIAGRAM FOR 5 WISCO ER-6-6  
 OR SOILTEST TS-BAG BATTERIES, 6VOLTS  
 "OPERATE" = SERIES CONNECTION  
 "CHARGE" = PARALLEL CONNECTION  
 BOTH SOCKETS = AMPHENOL MS 3102A-14S-9S



BATTERY CHARGER FOR CESIUM MAGNETOMETER  
BATTERIES

Revised 5/67  
EKR



LITHIUM +  
CARBONYL  
NICKEL  
+ CMC



MONEL  
SCREEN



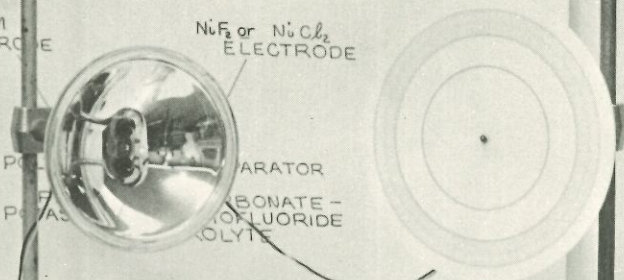
$\text{NiF}_2$  or  $\text{NiCl}_2$  +  
GRAPHITE  
+ GELATINE



LITHIUM  
ELECTRODE



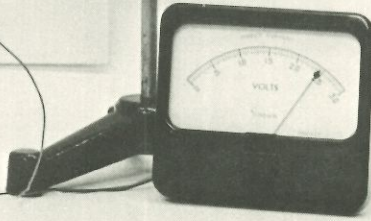
$\text{NiF}_2$  or  $\text{NiCl}_2$   
ELECTRODE

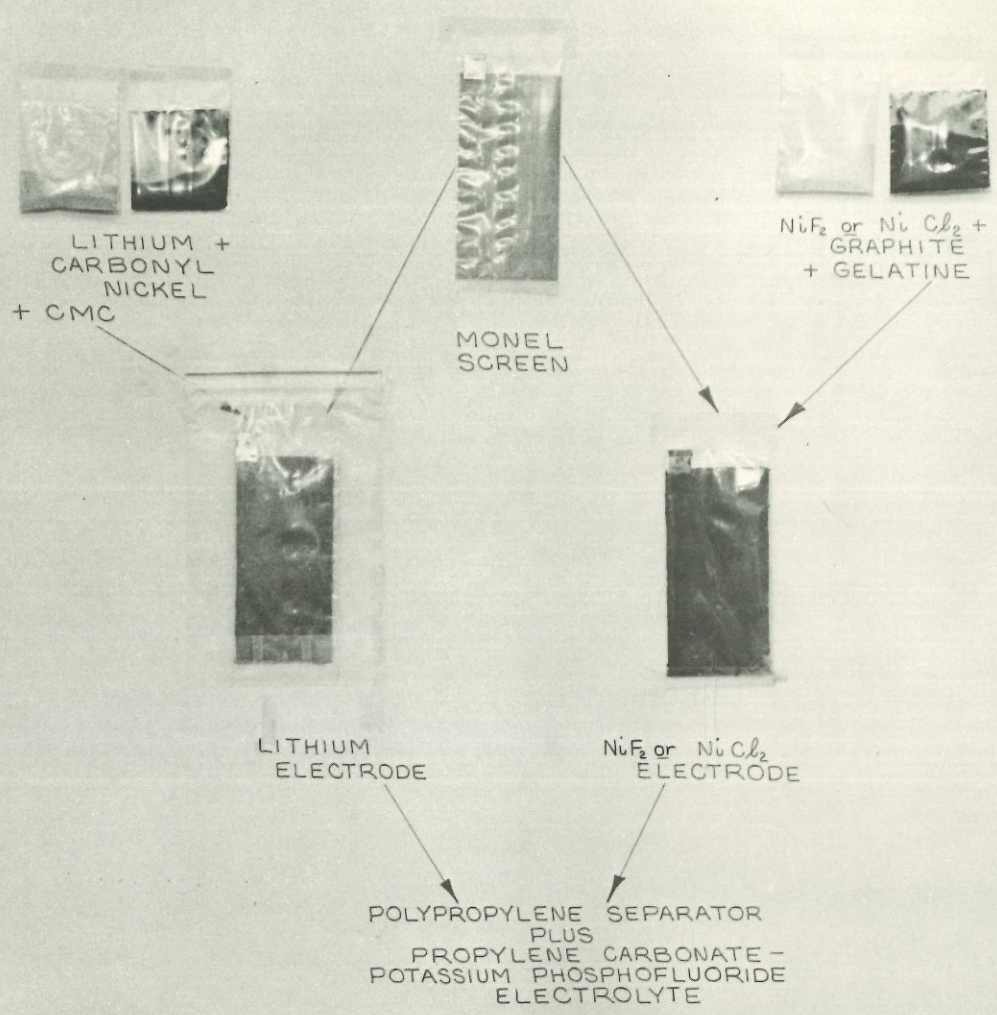


SEPARATOR  
BISPHENOL A  
POLYCARBONATE -  
LITHIUM FLUORIDE  
ELECTROLYTE

LITHIUM-NICKEL HALIDE CELL

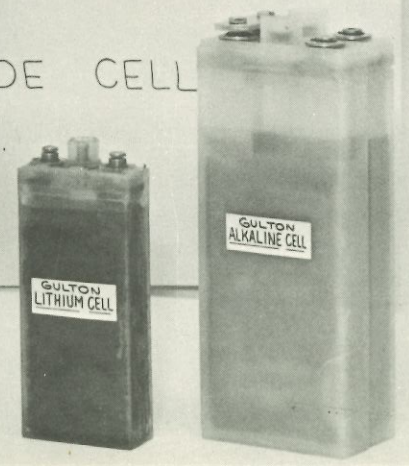
GULTON IND., INC.





LITHIUM-NICKEL HALIDE CELL

GULTON IND., INC.



GULTON INDUSTRIES, INC.  
212 DURHAM AVENUE METUCHEN, N. J.



NEWS RELEASE

For Immediate Release

GULTON INDUSTRIES ANNOUNCES  
DEVELOPMENT OF LITHIUM BATTERY

Application Seen For Electric Cars

METUCHEN, N. J., Oct. 5 -- Gulton Industries, Inc. has announced development of a new lithium battery which could be used to power compact electric automobiles and carts.

In announcing the new battery, Dr. Robert C. Shair, vice president, research and development, noted that in contrast to the 82 mile range estimated for the Ford Motor Company's sodium-sulfur batteries, the Gulton lithium battery is expected to have a range of 150 miles without being recharged.

The lithium battery is a completely sealed cell composed of lithium and non-toxic, non-odorous inorganic fluorides, Dr. Shair stated. The new battery, combined with the Gulton exclusive fast charge Adhydrode which was developed by Gulton for nickel cadmium batteries, is capable of recharging within a few minutes for many thousands of times, he added.

"The Gulton battery, weighing 250 pounds, would provide enough energy to propel a compact automobile for 150 miles without recharging. Research is currently underway to develop a smaller weight battery which should be available within the next two years," he stated.

Underscoring the significance of the new lithium battery in the rechargeable battery field, Dr. Shair said that the Gulton working lithium cell has a realized capability almost four times that of today's popular nickel cadmium batteries.

"The lithium battery is regarded as an outstanding compact energy source for long term assignments. Lithium's fundamental properties make it more efficient as an energy source in batteries than other metals," Dr. Shair reported.

Research has shown the lithium battery has a theoretical capability of 600 watt hours per pound, though the prototype has achieved only 100 watt hours per pound. This is still by far the most efficient battery type, topping nickel cadmium (26 watt hours), silver cadmium (35 watt hours) and silver zinc (75 watt hours).

"Lithium is a very plentiful metal, and while it is more expensive per pound than competitive battery materials, it costs less per unit of energy," Dr. Shair said. "It has a limitless potential in areas where a lot of portable power is needed and space is at a premium."

VD-109-A

# OAK MFG. CO.

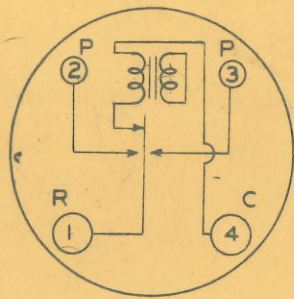
VD-109-A

## ENGINEERING DEPARTMENT

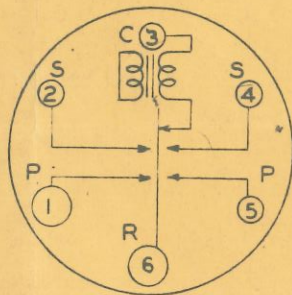
SUBJECT: BASE DIAGRAMS

PAGE NO. 21

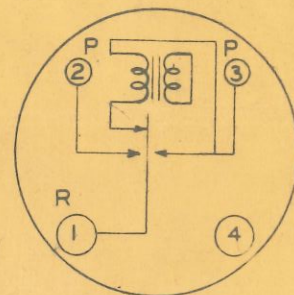
DATE 4-24-46



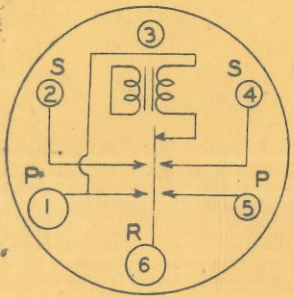
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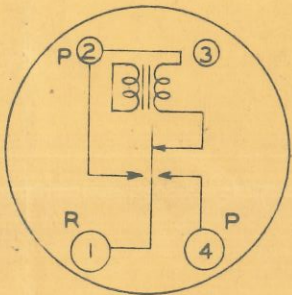
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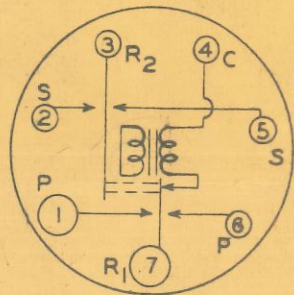
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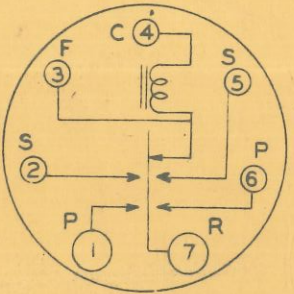
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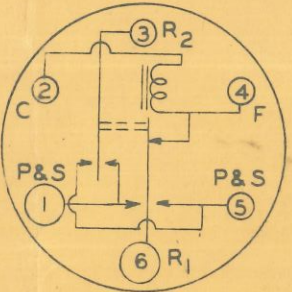
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6



7



8

### LEGEND:

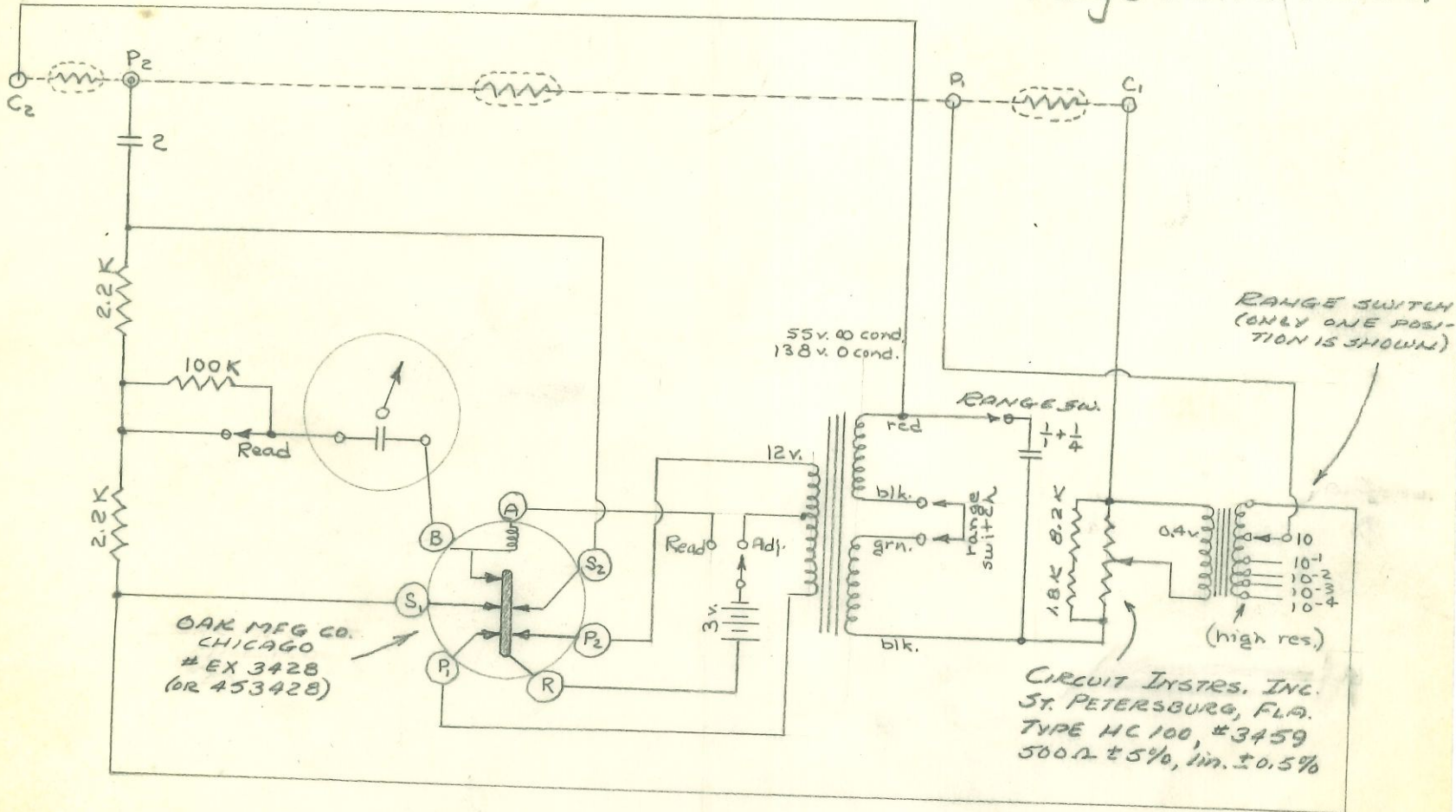
- C- Driving Coil Connection
- P- Primary Transformer Connection
- S- Secondary Transformer Connection
- R- Reed Connection
- R<sub>1</sub>- Primary reed Connection
- R<sub>2</sub>- Secondary reed Connection
- F- Frame Connection

Large pins .156" diameter.  
 Small pins .125" diameter.  
 Pins of 4 prong bases are  
 on a 1/8" diameter circle.  
 Pins of 6 & 7 prong bases  
 are on a 3/4" diameter  
 circle.

5/3/60

The number given this vibrator is used while it is in the experimental stage. A production number will be assigned when samples are approved and a production order is received.

Estimated Schematic Diagram with only one position of range switch shown



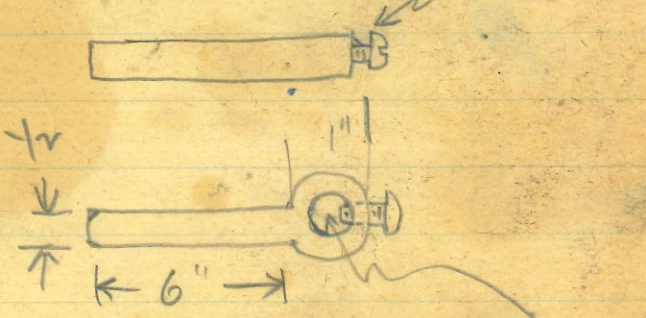
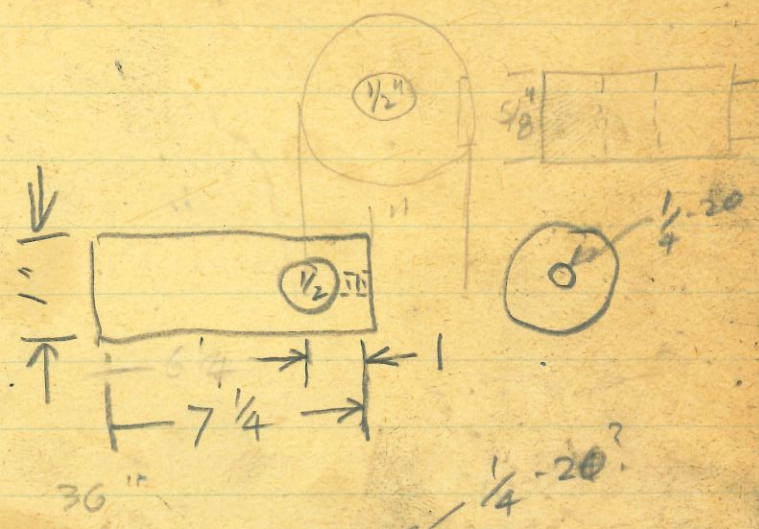
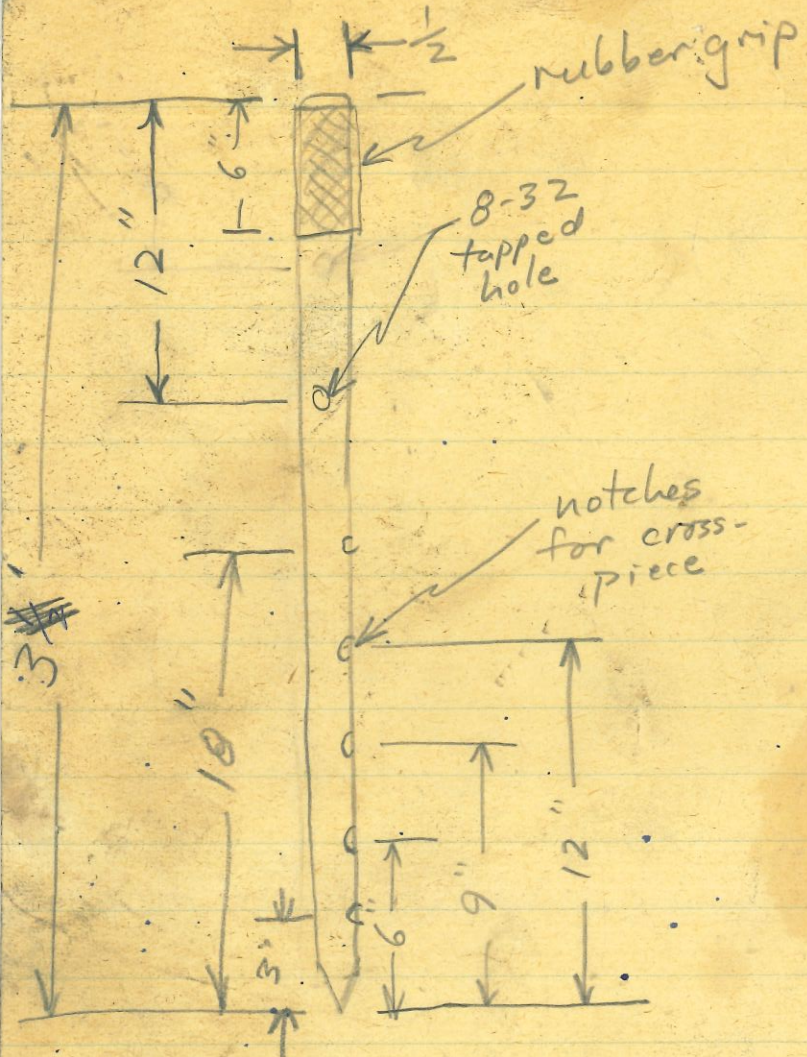
ASSOCIATED RESEARCH, INC.  
3758 W. BELMONT AV.  
CHICAGO 18, ILL.

MODEL 2741M MICHIMHO  
SER. NO. 274M59

DWN 4/22/60 EKR  
TRCD. 4/23/60 RS

Type 304 Stainless

5/17/61



to fit easily over 1/2 dia rod



Resistivity Instrument Rods

Make 15

E Ralph

~~NSF G-13256~~

EV-64220  
EV 2 320)