

~~TOP SECRET FROTH~~~~TOP SECRET FROTH~~Brief Description of Analytic Machine  
Fourth InstallmentNSA-34  
NSA-35  
20 September 1954  
Wheatley, LeRoy H.

The attached 36 brief descriptions in this fourth installment reduce the total machines remaining to be written to about 12. Of these, 8 are from the original backlog list; the others are recent equipments. These additional briefs together with a table of contents, glossary and index will follow shortly.

The CAMEL and CONNIE briefs being issued here are to replace the two already issued. Please remove and destroy these two, replacing them with the newer issues. This procedure of replacing certain older briefs with new ones will probably be used in connection with other published briefs.

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## CADILLAC

The term CADILLAC (AFSAF 31A and B, UNILITERAL FREQUENCY PHI and DELTA COUNTER) now refers to a pair of relay frequency counters which automatically supply character and baud totals and additional statistics. The first (AFSAF 31B), built by NSA-35 in February 1952, was originally called only by the full title UNILITERAL FREQUENCY PHI and DELTA COUNTER, but since completion of the second model, (AFSAF 31A) in March 1953, the term CADILLAC is regularly applied to both. The terms FREAK 1 and FREAK 2 were also applied earlier, but this conflicts with nomenclature of the old relay FREAK I (AFSAF 24) and the electronic FREAK II (AFSAF 31).

Both equipments have single 5-level tape input and CXCO regeneration typewriter output. The later model has an additional optional output to a tape punch. Total individual characters in the tape and total bauds by levels are tallied. Both compute delta which is a summation of differences between successive characters, a phi ( $\phi = \frac{n(n-1)}{2}$ ) on total characters and a phi on total delta of characters.

The first model is an upright relay rack whose dimensions are 6'H x 2'L x 2'D. The second is in the form of a console desk and measures 3'H x 5'L x 3'D. Rate for both is 6 to 8 characters per second. They are at Arlington Hall Station, the first in room 2054-A and the other in room 2050-B.

## Reference:

Completion Report "CADILLAC"  
Mr. S. Fedak

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## CAMEL

CAMEL (CML, CHARACTERISTIC MESSAGE LOCATOR) was a crib-tester consisting of six relay units used with a 405 TABULATOR to locate CI (Cryptographic Instruction) messages in Jap Army Traffic. It was built by F Branch of Army in February 1945. BABY CAMEL, a handtester employing similar principles, was built at about the same time and was used as a desk-top crypto-aid. BABY tested one 4-digit cipher position at a time, indicating possible placements on lights. It measured about 2'H x 2'L x 1'D and has been dismantled.

Attack was based on the characteristics of the 10 x 10 non-latin enciphering squares used by the Japs and the fact that each such square for the next cryptographic period was enciphered using the current square and sent as a CI message. This was usually recognizable as a long TENA series which is a long message sent as a series of parts. For a while, all messages intercepted in most Jap Army systems were processed on CAMEL.

The 6 units ranged in size from 7'H x 4'L x 3'D to 3'H x 3'L 2'D plus TABULATOR Rate was 6 tests per second. It was dismantled.

Such a CI message contained ten permutations of the ten plain code groups representing cardinal numbers 0 through 9 and sometimes the check-number code groups as well. Cipher and key were read from cards and the denials or square limitations (impossible plain text values which do not occur in the particular column of the square) were set on plugboards.

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CAMEL (Cont'd)

This last test was done manually in work on BABY CAMEL, by scanning a chart of possible plain groups. A marginal indication was given in the print out when one or more number groups are possible in each of the last 10 positions and further when no group was repeated, ie - when there existed one of the 10! permutations possible. For a while all messages intercepted in most Jap Army systems were processed on CAMEL.

The six relay units ranged on size from 7'H x 4'L x 3'D to 3'H x 3'L x 2'D plug TABULATOR. Rate was 6 tests per second. It was dismantled.

Reference: Completion Report, Proj. 1048  
NSA-82 files  
Mr. W. Erskine  
Mr. A. Highley  
Mr. F. Lewis  
Mr. J. Powers

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PL 86-36/50 USC 3605

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## CONNIE I and II

CONNIE (AFSAF 1, AFSAF DLA, HIGH-SPEED TELETYPE TAPE COMPARATOR) is a general purpose comparator which photoelectrically reads a pair of teletype tapes, electronically comparing and counting coincidences up to pentagraphic size. Model I was completed experimentally in January 1948 specifically for the  problem, at which time it was called HIGH-SPEED TELETYPE TAPE COMPARATOR. Modifications making it general purpose were completed in October 1949, at which time it came to be called CONNIE I (AFSAF 1). An experimental equipment called GRICE (from Group I.C., rhymes with price) was completed in 1951 to develop and test circuitry for a new CONNIE, but was not designed for operational use. CONNIE II (AFSAF DLA, formerly ASAF 1-1, EXPANDED CONNIE) was built by National Union Radio Corporation and delivered in July 1954. IDA (AFSAF D52, formerly ASAF 1-X) is essentially a stripped-down CONNIE built by NSA 22 in 1950 and 1951 and is described under that title.

Input is by a pair of photoelectric tape readers operating at 5000 characters per second. Output, which was to an undulating pen-tape in the earliest model, is now a pair of AFSAF 44A DIGITAL RECORDERS. In the fall of 1951, four Remington Rand card readers were added to hold one stationary card apiece and supply a crib or pattern, such as for a notched wheel, thus simulating regular wheel motion. Characters are scanned, stored electronically and treated cyclically in making successive matches between texts. Essentially an IC machine, it counts baud coincidences, combines these internally for

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CONNIE I and II (Cont'd)

character coincidence and matches totals against a preset threshold.

CONNIE II will have several improvements: a 32 x 32 magnetic binary matrix, a criterion generator with a variable threshold print control and an auxiliary storage unit. It will handle larger numbers at a faster rate and will permit weighting and variable grouping. A choice of IBM 517 SUMMARY PUNCH or AFSAF 44A DIGITAL RECORDER is provided for output.

Model I measures 8'H x 33'L x 2'D plus the tape reader and rate is 5000 comparisons per second. Model II measures 7'H x 72'L x 3'D plus tape reader and SUMMARY PUNCH. They are located at Arlington Hall Station, the first in 0413-B and the other second court, basement of B building.

## References:

M.A.C. Outline #56  
Mr. W. Cole  
Miss M. Hobbs  
Mr. J. Powers  
Mr. T. Roland

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## COORDINATING REPRODUCER

The 797 COORDINATING REPRODUCER (NC-4 MARK II SELECTIVE PUNCH, CXNT) is a special card-punch equipment to do transcribing, gangpunching, comparing and, when used with a matrix gate, matrix combining or substitution according to almost any desired rule. Ten of these reproducers have been built for the Agency by International Business Machine Corporation, the first arriving in early 1950. It replaces the NC-2 RELAY ADDER, the early NC-4 SELECTIVE PUNCH (CXNB), the PRE-SENSING PUNCH and a number of special substitution devices. CONSECUTIVE NUMBERING DEVICE designates a bit of internal circuitry built locally installed in one for numbering cards, necessitated by the non-standard card feed.

Effectively, the machine makes it possible to read from a card and perform certain calculations and substitutions, punching the results into the same or a different card. Effectively, it determines if one of a pair of values is equal to, less than or greater than the other. Used with a gate such as the MATRIX GATES (AFSAF 104), random substitution, matrix substitution and both normal and non-carrying addition or subtraction. Large volume decipherment is one obvious application.

The 797 measures 4'H x 6'L x 2'D and operates at a rate of 100 cards per minute. Six are in use at Arlington Hall Station in NSA 82, in A Building, and four are stored.

## References:

MAC OUTLINES #49  
Mr. S. Thorne

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DECIMATOR

DECIMATOR (no AFSAF number, REGEN-SPACER-TAPE-DECIMATER) is a special tape-processing relay device used to select and reproduce characters in specified position in a tape. One only was built by NSA-82 in 1951.

A cipher tape and a selector (control) tape are read by a TDY double-headed reader and only those characters in cipher which fall opposite a control punch in the selector tape are reproduced in a new tape. Spaces, as for forming text into groups on these resulting from decimation, and feed-outs may be inserted or eliminated as desired. The position of characters selected for reproduction need not be a regular pattern. A CXCO regeneration typewriter for page copy is optional.

Size is 1'H x 1'L x 1'D plus TDY reader, CXCO regeneration typewriter and tape punch. Rate is 6 to 8 characters a second. It is in use at Arlington Hall Station in room 2050-B.

References:

Miss K. Blank  
Mr. G. Lockhart

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## DEFROST

DEFROST (AFSAF D69 and D69A) is a microfilm viewer-reproducer, designed to produce with speed and convenience a photocopy of selected portions of a roll of film. NSA-35 developed 3 models using 16mm film, the first two purely experimental. The later model of the two, completed in December 1953, was given a 6 month floor test. Currently, AFSAF D69A, a production model, is being developed and is near completion. It will serve as prototype for 30 copies to be built on contract. Independent of the local effort, a contract with Remington Rand Corporation produced AFSAF D69 which handles both 16 and 35mm film. It was delivered in July 1954. DEFROST (project 355-7212) originally started as part of FREEZER project (354-7205, formerly 351-434-53) and is one of the several document reduction devices developed as part of the major program here at the Agency to mechanize the handling of the huge volume of intercept traffic and documents in general.

In operation, a roll of developed film, usually 16mm, is threaded onto spindles and pulled through a light beam by motor. Contents are projected onto ground glass, permitting the viewer to select any desired portion for reproduction. A push button sets off a mechanism which automatically exposes the chosen portion onto an 8 x 10 paper, develops it and ejects it ready for use.

The earliest breadboard model has been dismantled. Both AFSAF D69 and the second experimental model measure approximately 4'H x 2'L x 4'D. They are located at Arlington Hall Station in room O217-B. The AFSAF D69A model will deliver a developed print in about 20 seconds.

## References:

Mr. E. Fleming  
Mr. J. Russell

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PL 86-36/50 USC 3605

## DEMON I-III

DEMON (I = CXNP; II = AFSAF 77, CXNS, III = AFSAF 78, CXOX) is an

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[REDACTED] All five were built by Engineering Research Associates.

Model I was delivered in October 1948 and was the first machine to operate with a magnetic drum at this Agency. Five of Model II were planned but only two were built, delivery being in April and December 1950. Serial 1 of Model III came in May 1952, and Serial 2 in June 1954. A 25-POSITION DEMON PUNCH CHECK (AFSAF 77/10) was developed to check tapes and a CONTROL LEVEL GENERATOR (AFSAF D58) to insert 7-level control punches. The TAPE PUNCH VERIFIER (AFSAF D67) serves to check both ATLAS and DEMON tapes.

[REDACTED]

[REDACTED] All models use 5-level tape input; output is to a CXCO regeneration typewriter and/or a 517 REPRODUCER.

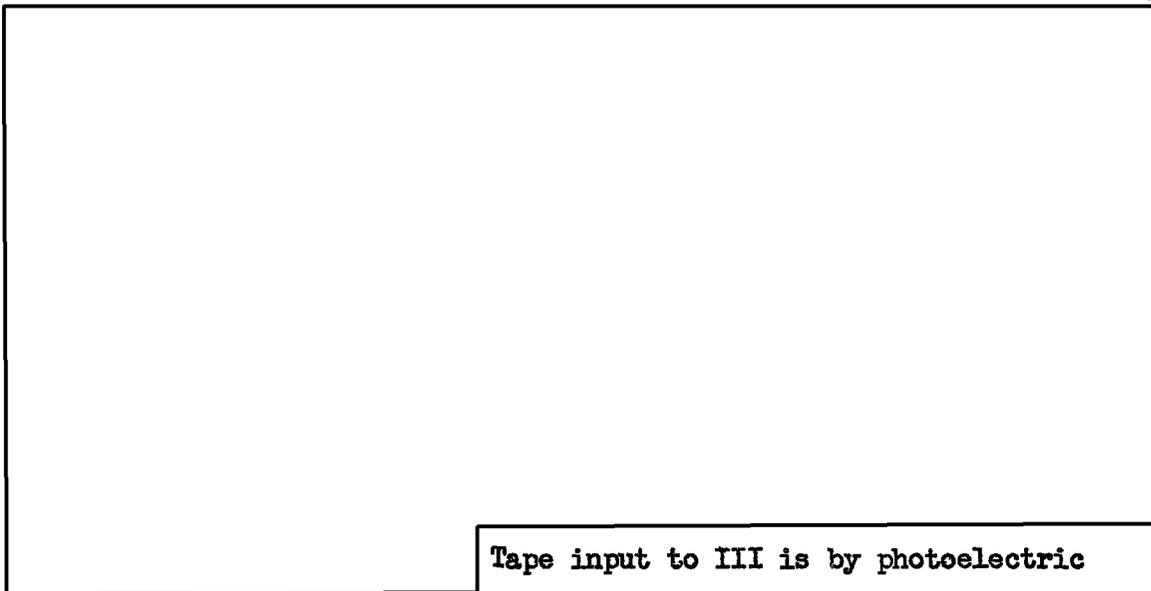
DEMON I, specifically for [REDACTED]

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DEMON I-III (Cont'd)

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Tape input to III is by photoelectric reader, but is by mechanical CXCO reader in the earlier two.

DEMON I, now dismantled, was a bay of equipment 7'H x 20'L x 4'D plus input and output devices. II consists of two such bays, and III of four such, requiring over 1,000 square feet of floor space. Operating at 3500 drum revolutions a minute, the rate of operation is all cribs tested in one position every second. Serials 1 and 2 of II and Serial 1 of III are in operation at Naval Security Station in room 4050.

References:

T/CA 20, 20/51, and 20/52  
Miss M. Hobbs  
Mr. D. Ream  
Mr. F. Smith  
Lt. F. Sperberg  
Mr. J. Stapleton

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## DERVISH

DERVISH is a project (353-7406) to develop package electronic units which can be assembled and disassembled as required by each specific problem. NSA-35 is doing the planning and development, but is contracting for any fabrication to be done. A few specific machines using these packaged units are being considered. The major goal is to reduce the problem of constructing special devices to one of appropriately interconnecting component units.

A few specific wired rotor problems using combinations of these sub-units are now under consideration and serve as a guide in development of such units. One such device assembled to test their feasibility is BRIDE, an electronic wired-rotor analog and cribdragger. It consists of a rotor analog unit, a modular addition unit, a counting unit, a memory storage unit. It enciphers or deciphers text at 167 KC per second.

Size of this demonstration model is a rack 6'H x 5'L x 3'D plus the particular input and output selected. Basic pulse rate is one megacycle per second. It is at Arlington Hall Station in room 0200-B.

Reference: Mr. R. Bowman  
Mr. A. Hesse  
Mr. E. Marston

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## ENIGMA ANALYTIC MACHINERY

An introduction to the ENIGMA cipher device itself is the best approach to understanding the array of Agency equipments developed for the ENIGMA problem. The Wehrmacht or German Army model is a battery-powered three-rotor device; the several Kriegsmarine or German Navy models usually have four rotors. Thus a cycle of  $26^3 = 17,576$  or  $26^4 = 456,976$  reciprocal alphabets is involved. At any setting, the 26 letters are paired off as terminals of 13 circuits passing through the rotor maze and back. Pressing a key sends current through the rotors, on through a reflector or reversing wheel, back through the rotors and out to a lamp labeled with the corresponding paired letter which is its cipher equivalent.

In terms of cryptograph this means that the same circuit which enciphers plain A to cipher B also serves to encipher plain B to cipher A, a switch serving to interchange the input-output roles of keyboard and lamp-bank. Note that a letter cannot encipher to itself and that the encipher-decipher alphabet at every setting is reciprocal. There are provisions on all military models for a mono-alphabetic substitution on the maze output which is known as stecker or endplate plugging; recovery of this variable is the main purpose of all BOMBE equipment. To accomplish this steckering, the Germans regularly used a set of ten double-wire plugs. This forces a further reciprocal relationship between letters, leaves six self-steckered letters and reduces by a large factor the permutations possible, permitting usage of reciprocal boards (DOUBLE INPUT CONTROLS, AFSAF 21 and 22) which greatly increase the effectiveness of each test.

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ENIGMA ANALYTIC MACHINERY (cont'd)

All rotors are removable and may be inserted in any order. The core of each rotor contains the wiring which performs the basic substitution and can be set at any of 26 points against the ring or tire which bears the alphabet and the motion-controlling notch pattern.

Analysis of any ENIGMA traffic must consider all or part of the following list of variables in the machine:

1. rotor wiring
2. reflector plugging (permanent in some models)
3. stecker, end-plate plugging (permanent in some models)
4. rotor order
5. window setting (starting point)
6. ring or core setting (permanent in some models)
7. notch pattern

All the cribtesters and draggers discussed here require that variable 1 be known and all take care only indirectly of variables 4, 6 and 7. This whole complex of machines devised to attack the ENIGMA may be considered in three categories: BOMBES, SCRITCHERS and miscellaneous auxiliary devices and attachments.

The term BOMBE applies to a diversified family of very specialized cribtesters, both relay and electronic, designed to solve traffic on several ENIGMA models by exhaustive trial. Army, Navy and GC & CS (now called GCHQ) in England each developed their own devices relatively independently, resulting in a great variety of models, modifications and attachments. The Army and Navy BOMBES are described separately under their respective headings. A BOMBE is in effect a number of double-ENIGMA analogs preset at fixed relative intervals according to a menu (crib-versus-cipher letter pairings) and pulsed in tandem. It tries a crib

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ENIGMA ANALYTIC MACHINERY (Cont'd)

in all possible rotor orders at all possible settings. A test pulse is sent at each setting through the maze to a cross-patching board representing all possible steckers and back through the rotors to a set of test relays. At wrong settings all 26 relays will usually carry current, indicating that no unique circuit exists, and accordingly the machine steps automatically to the next setting. When one or more relays fail to receive current, the BOMBE stops, records the settings and continues testing.

Included in the family are the Army MADAME X (AFSAF 14, 003 RELAY BOMBE), the NAVY BOMBE (AFSAF 23, CXGQ, models 530 and 1530) and the British JUMBO equipment. Modifications and usages produced the SWISS CRIBDRAGGER (AFSAF 15 and 16), FIRE ENGINE, GRANDDAD, ARLINGTON DUBBUSTER (AFSAF 17, AXDQ/1) and JONES DUBBUSTER. Plans were cancelled for AZALEA and BACHELOR, both versions of a HIGH SPEED CRIBDRAGGER (AFSAF 43) to do testing with photoelectric cells. The DERVISH project (353-7406) is aimed at developing unit components for use in various combinations as specific analytic devices. One such experimental set-up, called BRIDE, operates at megacycle rates as an ENIGMA analog and cribdragger.

The SCRITCHERS are designed to do the full BOMBE test for steckering plus an additional test for reflector plugging. This category includes the AUTOSCRITCHER (GRAPEVINE), the SUPERSCRITCHER (AFSAF 18, SEQUENCE TESTER) and the five Navy DUENNAS (no AFSAF number, N-1500, CXLU), all described under their own headings. Given rotor wiring, a known or easily assumed

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ENIGMA ANALYTIC MACHINERY (Cont'd)

motion and a crib of 100 or more letters accurately placed, a SCRITCHER successively assumes all steckering and reflector plugging combinations and tests each against the full cycle of the two rotors chosen. Since the slow wheel or wheels are assumed to be motionless, they may be considered a unit with the reflector, producing only a monoalphabetic substitution. When a possible setting is found, the machine stops, makes a record and continues testing. Plans for a pair of one-wheel BOMBE-type cribtesters to be called MONA (N-1100) were dropped in favor of DUENNA. Comparable British equipment is called GIANT. Details are lacking but there was a pair of GRENADE-type equipments unofficially called COCA COLA and PEPSI COLA which operated as SCRITCHER controls.

The third or miscellaneous category is quite numerous. The largest single group in it is the GRENADE family, all limited purpose message setters which operate as BOMBE attachments and controls. It includes the five STANDARD (N-1900), one PARALLEL, one MULTIPLE, one DRAG, two SLIDING (N-1700), one PLUGGABLE SERIES, one MEDUSA and one POLYGRENADE (UNIVERSAL PLUGBOARD). CILLY and QUERY GRENADES were usages on a STANDARD GRENADE. The Army CLAMBAKER (AFSAF 20) was actually a GRENADE. So also is the photoelectric HYPO (AFSAF 101), a RAM film comparator which applies a statistical letter frequency test. All serve to find window settings when all other variables are known, and all but HYPO and DUBBUSTER use a crib, usually of 4 or 5 letters.

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ENIGMA ANALYTIC MACHINERY (Cont'd)

Other devices in the third or miscellaneous category include the M-8 DECIPHERING DEVICE, the M-9 HANDTESTER (OPAL, N-550, N-1800, N-2400), the BOA wheel (N-2300), M-10 PRINTER (N-1000-8), the JONES DUBBUSTER, FILIBUSTER, OYSTER SHUCKER, DOUBLE INPUT (AFSAF 21 and 22), MACHINE GUN, FALSE STOP ELIMINATOR, SQUELCHER (CONFLICT SUPPRESSOR), PRINTER TESTER, SELF DETECTOR and numerous unnamed circuit testers and plugboard checking devices.

In the following chart, the numbers in the two columns at the right refer to the seven variables listed in paragraph three:

		GIVEN	TO FIND
AUTOSCRITCHER	crib, up to 200 ltrs.	1	2,3,4,5
BOMBE	crib, about 16 ltrs.	1,2	3,4,5
CRIBDRAGGER	crib, 5 to 10 ltrs.	1,2	3,4,5
DUBBUSTER	letter freq. test	1,2,3,4	5
DUEENNA	crib, up to 100 ltrs.	1	2,3,4,5
GRANDDAD	crib, up to 32 ltrs.	1,2	3,4,5
GRENADA	crib, 4 to 5 ltrs.	1,2,3,4	5
HYP0	letter freq. test	1,2,3,4	5
SUPERSCRITCHER	crib, up to 100 ltrs.	1	2,3,4,5

## Reference:

M.A.C. Outlines No. 9, 16, 18, 20  
 GYA 450 Reports  
 Mr. J. Stapleton  
 Mr. G. McDonald

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## FILM COMPARER

FILM COMPARER, a term which normally designates a general class of equipments, was once used to designate a particular, rather unimportant optical cribtester for machine superimposed films to find by eye possible settings of Jap PURPLE wheels. It was built by F Branch of Army, Project 6-5089, in 1945 but never became operational.

The device handled only 20 letters of the alphabet, the remaining 6 always being handled by a 4th wheel in the Japanese machine. It was little more than a light viewer box designed to accommodate 3 or 4 hand-inserted TESSIE films (the type used in ICKY I) chosen from a library of 400 films. Each film contained all possible wheel settings and the corresponding plain-cipher pair, represented as a  $25 \times 25^3$  matrix, and identification of this film was this plain-cipher pairing as a digraph, A to A, A to B etc. With 3 or 4 such films superimposed, light coming through at any point indicated a possible setting which could be checked by deciphering the preceding or following text at the suggested setting.

Size was 1'H x 2'L x 1'D and rate was operator's speed, a crib tested at one point in about 30 or 40 seconds.

## Reference:

Mr. E.D. Marston

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## FREQUENCY COUNTERS

Frequency counters constitute one of the largest categories of analytic machinery in the Agency. A great variety of these, some nameless and some now forgotten, has been developed and built in the past 12 years to count bauds, to count characters, both monographic and polygraphic, to count repeats, etc. Aside from the larger, well-defined ones such as FREAK I and II, MIKE, ALCATRAZ, and the "CADILLAC-FREAK" pair, all described elsewhere, the following listing is as nearly exhaustive as possible. Also excluded are equipments with markedly different additional functions or those in which counting is incidental to another prime function.

As early as 1942, the Army had informally and without benefit of record or name put together the first of a number of breadboard models all basically the same, using from 5 to 104 visual type mechanical counters to tally pulses. These counters are normally mounted on a board and operate from keyboard or tape reader. Most popular is the 3 x 4 array for frequency counting digital traffic, furnishing a tally of digits, plus dits and an overall character count. Several are still in operation in some of the divisions. In 1943, the Army purchases a tiny, gear-driven, nameless device which ran a CXCO tape manually over a tape-feed mechanism and gave a visual total of characters (actually the number of feed holes) on a small counter. It was used to locate hits indicated by the I.C. MACHINE and TESSIE equipment.

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## FREQUENCY COUNTERS (Cont'd)

The DIFFERENCE COUNTER, built by NSA-82 in 1950, is typical of such devices, using a set of 12 counters to take differences between two tapes. It has a TDY double-headed tape reader input and gives a straight numerical count of differences between characters, plus dit count and overall total. It is in use at Arlington Hall Station in room 2054-B.

In 1951, NSA-82 built an 8 x 13 bank of visual counters mounted on a 2' x 3' inclined board. It has no particular name and operates with tape equipment to provide counts in up to 104 categories. Rate is 6 to 8 characters per second. It is also in room 2054-B. One hook-up of this with a TDY double-headed reader and particular relay box 2'H x 1'L x 1'D is called DINOME COUNTER. The tapes supply respectively the initial and final half of the dinomes being counted.

Another device involving this 104-counter board is called OVERLAP COUNTER (no AFSAF number). Using a TDY double-headed tape reader and a particular pair of relay boxes 2'H x 1'L x 1'D, the device automatically makes a frequency count on a width up to 250 of the occurrences of a selected two-baud pattern, such as / / , for example. This pattern is formed by successive characters in a tape or between tapes. Single bauds (hole or no-hole) can also be counted.

Once in 1944 and again in 1948, Navy connected a pair of 15-window counter-banks from an IBM 075 CARD SORTER to a double-headed CXCO tape reader and called each of the units by the simple but ambiguous title FREQUENCY COUNTER (also STANDARD or SIMPLE FREQUENCY COUNTER). They are still stored at Naval Security Station. The MONOMIC COUNTER, also at Navy, consists of one such 15-window counter bank and a digital keyboard. It too is at Naval Security Station in building 4.

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## FREQUENCY COUNTERS (Cont'd)

The ALCATRAZ contract also produced BABY ALCATRAZ (6 x 6 CB, CXMH) in October 1949, containing a 6 x 6 array of counters of the same type and size as in ALCATRAZ. Counter contents may be read out visually or electrically. It is in use at Naval Security Station. Size is 6'H x 3'L x 3'D, input rate is 8 characters per second and output rate using its own printer, type 10 AVN, is about 4 characters per second. Used with a special BASE-10 MATTHEW (4'H x 2'L x 1'D), built by NSA-35 in 1950, whose 10 x 10 matrix output goes directly to the counters through a 20 x 34 plugboard, the whole set-up is called MATTHEW-SIMON BASE-10 FREQUENCY COUNTER (XBL). No clear agreement exists on the term SIMON, or SIMPLE SIMON. It usually refers to FREQUENCY COUNTER (STANDARD or SIMPLE FREQUENCY COUNTER) but is sometimes also applied to MONOMIC COUNTER. The MANUAL COUNTER (AFSAF 50, MOD 10 FREQUENCY COUNTER) was built by NSA-35 in January 1953 for straight digital counting. No details are available. DIAC (AFSAF D122, DESK DIGITAL COUNTER) is being developed under project 355-7600. It also has been termed a MANUAL COUNTER and a MOD 10 FREQUENCY COUNTER, making nearly impossible the task of distinguishing these last two devices.

The MOD 2 DEVICE (MOD 2 ADDITIVE MACHINE), also described under TAPE COMPARATORS, has both a baud combining and character counting function. The KOREAN COUNTER, a portable monographic frequency counting device, was built by NSA-35 for ASAPAC in 1950 and may not properly belong in this listing. It consists of 38 visual counters, 32 for the set of Baudot characters, 5 for baud levels and 1 for overall total. Input is by keyboard and speed is less than 10 characters per second. Navy completed a nameless THIRTY-TWO CHARACTER FREQUENCY COUNTER in June 1945, but no details are available. It has probably been dismantled.

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## FREQUENCY COUNTERS (Cont'd)

DELTA COUNTER (AFSAF 107) has 6 mechanical counters for totaling delta (change or no-change between successive character bauds) for 5 levels in a tape and an overall character total. It has a TDX single-headed reader input, a tiny 1' x 1' x 1' relay box, the counterboard and optional added outputs to CXCO regeneration typewriter or tape punch. Location is at Arlington Hall Station in room 2054-B. Rate is 6 to 8 characters per second.

The DELTA-DOT-CROSS COUNTER (AFSAF D56), built by NSA-35 in 1952, counts runs of consecutive /'s or -'s in 5-level tape. It does this 5 levels at a time and is limited to 13 bauds of each type (or 26, all of one kind). It gives 5 subtotals for /, 5 for -, and an overall total, using in all 141 counters. It is in use at Naval Security Station in room 17B35. Size is 6'H x 5'L x 1'D and rate is 6 to 8 characters per second.

RUN COUNTER (no AFSAF number) was built by NSA-24 in 1948 and, like the DELTA-DOT-CROSS COUNTER, counts runs or sequenced of up to 16 consecutive holes or no-holes, but only one level at a time. It contains 32 counters and stops automatically when the capacity is exceeded, permitting the operator to hand-step the tape through the remainder of the run. It consists of a TDX single-headed tape reader input, 1'H x 1'L x 1'D relay box connected with the 8 x 13 counterbank, all located at Arlington Hall Station in room 2054-B. Some confusion arises from occasional application of the name RUN COUNTER to the DELTA-DOT-CROSS COUNTER.

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## FREQUENCY COUNTERS (Cont'd)

COUNTING DEVICE for CARD-OPERATED TYPEWRITER and HORACE (AFSAF 116), both described elsewhere under their own titles, are two IBM frequency counting devices. The first operated from tape with an O58 CARD-OPERATED TYPEWRITER at a rate of 8 to 10 characters per second and is now dismantled. HORACE is used with a 407 TABULATOR and counts punches in any 11 of the 12 levels of a card. Rate is 150 cards per minute. It is located at Arlington Hall Station in the 8th wing, A Building.

## References:

Brief Descriptions of RAM Equipment  
CIT paper 51  
SIMON Completion Report  
Miss K. Blank  
Mr. K. P. Cook  
Mr. G. Lockhart  
Mr. R. Nothnagel  
Mr. J. Russell  
Mr. J. Stapleton

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September 1954

## GENERAL PURPOSE COMPARING GATE

The GENERAL PURPOSE COMPARING GATE (AFSAF 110-B, OPPOSED-COIL COMPARING GATE) is a general purpose repeat search and comparing device used originally in conjunction with a 513 and later either a 519 REPRODUCER or 797 COORDINATING REPRODUCER, usually to do isomorphic and pattern search. One model was built by NSA-22 in 1948, designed to do any type comparing. Plans by Navy for SQUINTER (CXOH), an optical general comparator to compare texts in IBM cards and find high points of IC by actually beaming light through a deck of cards, were dropped in favor of other methods such as this gate.

In effect, the device permits comparing 80 columns vs 80 columns using double-wound coils. It has a flexible, completely inter-pluggable arrangement permitting connection of output to any character desired. It can reduce as many as 13 columns of characters to isomorphic patterns. There are  $\frac{13 \times 12}{2}$  positions needed to show full isomorphic pattern of a 13-character long sequence. A counting circuit was added to record total of up to 6 equal characters, or matches. Input and output are by card.

Size is 3'H x 3'L x 2'D and rate is 100 cards per minute. It is currently available for use at Arlington Hall Station in NSA-82 area, building A.

## Reference:

Mr. S. Thorne

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September 1954

## GENERAL PURPOSE SETTING GENERATOR

The GENERAL PURPOSE SETTING GENERATOR (AFSAF 115) is a relay gate used with a 513 REPRODUCER PUNCH to simulate any particular cipher device or key generator. Little used since the SETTING GENERATOR (AFSAF 35) began operation, it was built in September 1950 by NSA-22 together with its associated ADVANCING ALPHABET CIRCUITS.

The gate consists mainly of a collection of relay bases, connectors and terminal blocks so mounted in a small frame to facilitate wiring the parts as an analog to the particular machine in question. Wiring is done internally on the relay bases, a relatively simple job, according to ideas and principles developed during the TAN problem. At various times while doing the following particular jobs, it has been called the MODIFIED BINARY MOTION SETTING GENERATOR, HALLMARK SETTING GENERATOR (HALLMARK KEY GENERATOR) the NRL (for Naval Research Laboratory) KEY GENERATOR and a HAGELIN setting generator. Plans were dropped for a second HALLMARK SETTING GENERATOR. The ADVANCING ALPHABET CIRCUITS, a set of 12 relays units providing identification alphabets of up to 26 characters, is used exclusively with the GENERAL PURPOSE SETTING GENERATOR to label recorded wheel settings. A "W-eliminate" switch has been provided for easy application to HAGELIN problems.

The relay gate containing this pair of units is available at Arlington Hall Station in room 1700-A, but would have to be modified to operate with a 519 REPRODUCER, since no 513 is available now. Size of the gate is 3'H x 3'L x 2'D and rate is 100 cards per minute.

## References:

Mr. J. Powers  
Mr. S. Thorne

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September 1954

## GRENADES

A GRENADE (CXMV) is any of a series of messages setters, used as auxiliary attachments to a NAVY BOMBE (AFSAF 23). They are essentially pluggable switch banks to control operation of a BOMBE so as to find window settings of ENIGMA enciphered messages in a solved period. Several types were developed by Navy and built by National Cash Register Company, the earliest in 1943. Comparable Army devices such as CLAMBAKE (AFSAF 20) or DUBBUSTER (AFSAF 17) were fully equivalent but were seldom called GRENADES.

A known steckering (daily plugging) is required and a properly placed 4 or 5-letter crib is usually sufficient. There were sixteen STANDARD GRENADES (M-256, N-1900) each consisting of a long panel of switches. One PARALLEL GRENADE (M-252) permitted running four 4-letter cribs simultaneously on one BOMBE. One MULTIPLE GRENADE (M-332) used five letters to do the usual job on traffic from four multiplenotch wheels. One DRAG GRENADE (M-265) tried four cribs simultaneously at all adjacent positions within a span of 16 letters, under certain limitations on input and output points. Two SLIDING GRENADES (M-253, N-1700) handled the added difficulty of a rotating reflector wheel by considering it a fourth wheel. One PLUGGABLE SERIES GRENADE aimed at recovery of wheel order and ring setting in traffic with "double grune" or two basic indicator settings. The POLYGRENADE (UNIVERSAL PLUGBOARD) was a generalized plugboard and switching arrangement used with the MEDUSA GRENADE (M-317). It permitted testing new ideas without special equipment and tried up to 26 cribs in 13 positions. The cribs, however, had to be non-unique and involve no more than 16 letters of cipher. The CILLY GRENADE and the QUERY GRENADE were usages, not devices, the first dealing with the fact the Germans often changed wheel

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GRENADES (Cont'd)

order by a cyclic shift and the later concerning a special case of double grund or daily window setting usage. Both were done on a STANDARD GRENADE.

CLAMBAKE (AFSAF 20) operated as a GRENADE control to MADAME X. HYPO (AFSAF 101), described elsewhere, is a RAM film comparator which sets messages through use of a letter frequency statistical test and as such was effectively a GRENADE. No details are available on the JONES DUBBUSTER or the pair of control equipments known unofficially as COGA COLA and PEPSI COLA beyond the fact that all three belong in this category and the latter two are associated with the SCRITCHERS.

Prints from a GRENADE run show only the position where the hit occurred. None of this equipment had great weight or bulk, the largest being the PLUGGABLE SERIES GRENADE, 4'H x 4'L x 4'D. All operate at BOMBE speed, 50 seconds for a 3-wheel run. All but the STANDARD GRENADE have been dismantled. Three of these are now in operation at Naval Security Station in room 4172 and thirteen more are stored in Mechanicsburg, Pennsylvania.

## Reference:

GIT papers 3,14,17,25,26,53  
 GIT-TS 1,2,3,15,18,19,26  
 GYA 450 Report  
 Pictorial Record  
 Mr. G. McDonald  
 Mr. J. Stapleton

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## GYP

KEY COMBINER (no AFSAF) GYP (no AFSAF number, KEY COMBINER) is a desk-top relay tape comparator and differencer which adds two 5-level tapes mod 2 level by level counting coincidences between tapes. Three of the first models were built by NSA-22, the first in 1948. A fourth and, more flexible model was built by NSA-82 in 1953 to handle decryption of an increases traffic volume. The last acquired the name GYP which has been applied to the three earlier ones.

Input is by a TDY double-headed tape reader and output is to mechanical counters mounted on a board or optionally to a CXCO regeneration typewriter and punch. Two 5-level tapes are read in, compared by baud levels in a tiny relay box (like signs cancel, unlike give a punch or tally). Counters show coincidence totals on 5 level and are overall total. GYP is more flexible in that the 18 selections in the relay box are pluggable and input may be any 5 levels of a 7-level tape. This makes any rule of baud combination possible on GYP.

Size of the relay box is 1' x 1' x 1' plus tape reader, 1' x 1' counter board, CXCO regeneration typewriter and punch. Rate is 6 to 8 characters per second. All 4 are in use at Arlington Hall Station. One of the first model is used on the STURGEON in room 2048-A; the others are in room 205-B.

## References:

Miss K. Blank  
Mr. G. Lockhart  
Mr. G. Stahly  
Mr. S. Thorne

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## HAGELIN PEG PATTERN GENERATOR

The HAGELIN PEG PATTERN GENERATOR (XEB) is a relay desktop equipment to combine peg (pin) patterns and record them in tape. It was built by Navy in 1944 to replace a longer process on general CXCO Equipment. It consists mainly of the SATYR HEAD (AFSAF 102/10), which is a set of 6 C-38 type HAGELIN wheels electromechanically advanced, plus a built-in pulse control.

The output is 6 bauds representing activity or inactivity of pins in control position on the wheels, and is produced as a pattern tape on a CXCO punch. This tape, as usually used, may then be aligned with a cipher tape for a digraph count or width count (64 sort, etc.).

The generator is 1'H x 2'L x 2'D plus CXCO tape punch, and operates at 6 to 8 characters per second. It is in use at Naval Security Station in room 4152.

## Reference:

CIT Paper No. 15  
Mr. H. Lofink  
Mr. R. Notmagel  
Mr. J. Stapleton

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September 1954

## HAGELIN WINDOW SETTING GENERATOR

The WINDOW SETTING GENERATOR (no AFSAF number) is a relay setting generator to produce successive settings of HAGELIN wheels in any part or all of the cycle. Navy built two. The first, in 1948, operates with a REMRAND card punch. The 2nd, in 1950, uses a 513 REPRODUCER to record results.

Set up at a particular window setting, the generator unit continues automatically through the wheel cycle, producing and recording successive settings and a count of its position in cards, one card per position. Corresponding cipher text letters are introduced by tape from a CXCO reader for inclusion in the card.

The first measures 3'H x 2'L x 2'D and the latter is a desktop device about 1'H x 2'L x 2'D, plus tape reader and card punch. Operation is at 6 to 8 characters per second. They are at Naval Security Station in room 4157.

## Reference:

Technical Library  
Mr. R. Nothnagel  
Mr. J. Stapleton

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## HANDTESTERS

The function of a handtester is to provide the analyst a convenient and efficient means of checking suggested settings, keys, cribs and circuits, and to extend placed cribs. Keytester and cribtester are synonymous terms; this testing function is frequently found in analogs and deciphering devices. The easy transition to semi-automatic and fully automatic testing further dims the boundaries of the class.

Since 1940, a whole series of such testers has been developed and built many so unimportant as to leave no record. SILLY SUE (PURPLE HANDTESTER) was an electrical circuit tracer built by Army in 1940 for use on Jap diplomatic RED traffic, it was probably the earliest tester and is described in M.A.C. Outline No.8. The device was simply a large board on which three wired wheel mazes were represented as sets of electrical contacts. A metal rider on a sliding bar permitted selection and reading of any contact. It can be considered an experimental prototype to the PURPLE ANALOG which is described under that title.

Navy built the M-9 HANDTESTER as an auxiliary to the BOMBES. It consisted of endplates and stator's arranged to hold a variable number of rotors. All motion was supplied by hand. Input was by switches and output was to 1 of 26 lamps. A total of 72 was built between 1943 and 1945.

The term WIRED WHEEL HANDTESTER is obviously ambiguous but has been applied to specific machines. One model, was built by Army in 1946 from SIGABA parts and was called a WIRED WHEEL or HEBERN HANDTESTER (M.A.C. Outlines No. 8). It provided for assembly of up to twenty 26-point rotors and is described elsewhere under this title. Used with an adapter unit in 1947, one of these was

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called a B-211 HANDTESTER. It was superseded by the specialized tester described under that title. Another wired wheel tester, a simple panel with space to hold as many as ten 26-point rotors, is also called AFSAF-19. Several are stored in room 0200-B. A simple SWITCH HANDTESTER was built by Army in 1947 for use by the analysts, but no details are available.

Both HELLCAT I and II are a combination deciphering device and key tester. They are described separately. OBOE may also be thought of as a hand-operated cribtester, although the automatic testing feature of PICCOLO rather removes it from this category. The same may be said of FIRECRACKER, the GRENADES FROG, HECATE and other cribtesters. All these are in effect, test cribs but are excluded here because a handtester is normally thought of as slow and non-automatic.

## Reference:

GYA-450 Report  
M.A.C. Outline No. 8  
Mr. J. Russell

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## JOHN

JOHN (AFSAF 104A, LUKE, MONONOME-DINOME MACHINE) is a relay-type mononome-dinome counter and substitution device used for deciphering digital traffic. In August 1947, NSA 24 built an experimental bread-board model of this device and shortly thereafter a working model, both of which were called MONONOME-DINOME MACHINES and required a 10 x 10 MATTHEW as an auxiliary to strip key from the original cipher text, first step in the decipherment process. These recognized up to 3 mononomes and 70 dinomes, in the form of a 7 x 10 dinome square. Two more followed in July 1948 which included the MATTHEW function internally; these were the first to be called JOHNS and could recognize 4 mononomes and a 6 x 10 dinome square. Navy then built LUKE, (XEZ) essentially the same device, differing only in external appearance. This and all the later devices recognized up to 10 mononomes. All 5 of these earlier equipments have been dismantled. NSA-82 has built 8 more JOHNS, all basically alike, and numbered serially 1 thru 8.

In general, a JOHN contains two matrixes, one essentially a 10 x 10 MATTHEW matrix for stripping key from cipher by normal rules of digraphic substitution, such as C-K=P. The second is a specialized matrix which recognizes each digit of incoming stripped cipher 1 (as a mononome and prints out a substitution value directly or 2) as the initial half of a dinome and stores it in relays as a "side coordinate" to the matrix. In this latter case, the digit following is of course, automatically recognized as the final half of a dinome and a substitution value for it is typed out. Key and cipher are read from tape by a TDY double-headed

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JOHN (Cont'd)

tape reader. One CXCO regenerator typewriter records the intermediate stripped cipher and another lists the final decipherment.

All 8 existing JOHNS are much alike and measure 2'H x 2'L x 1'D plus a TDY double-headed reader and a pair of CXCO regeneration typewriter. Rate of operation is 6 to 8 characters per second. Six are in use at Arlington Hall Station in room 2048-A and two at Agency headquarters in Frankfurt, Germany.

## References:

MAC Outlines #52  
Mr. K.P. Cook  
Mr. G. Lockhart  
Mr. S. Thorne

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## JOOS TYPEWRITER

The JOOS TYPEWRITER was a relay polygraphic frequency counter built for Army by Dr. Martin Joos in 1943. It was superceded by various equipments such as ICKY I (TESSIE II) and the 70mm COMPARATOR (AFSAF 2).

Two texts to be matched for coincidences were read from tape on a double-headed reader and matched character by character in relay circuitry housed in a small box. At a coincidence, a CXCO regeneration typewriter recorded the particular character and continued recording successive characters until a non-coincidence occurred. This would cause the typewriter to line-feed and wait until the next coincidence appeared. The process resulted in a diagonal listing of all text coincidences, whether a single character or a polygraph, each shown on a separate line.

Size was about 1' x 1' x 1 plus reader and typewriter. Speed was about 4 characters per second. It was used at Arlington Hall Station and has been dismantled.

## References:

TICOM, Vol II  
Mr. A. Small

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JOSE

JOSE (JOSE ITURBI, PIANO) was a general purpose relay gate usually used with a 405 TABULATOR for a number of special jobs. Two were built by F Branch of Army in about 1945. It is replaced by equipments of larger capacity, such as the GENERAL PURPOSE 100 WIRE CONTACT RELAY GATES.

The device consisted of 50 pluggable 11-position class-selector relays and was used to increase selector capacity of some base IBM equipment. One usage was to list conflicts between patterns in plain-cipher pairs of one message and those of another message in a different conversion square period, thus finding impossible points of overlap. It was used in recovering of discriminant enciphering squares. In another usage, always requiring special wiring for the particular job, the device was used as a multiple crib drag, deriving possible key for matching against known key. Making a rhyming dictionary by lining up irregular length entries so as to end in the same column was another usage. For this last, the gate operated with a 513 REPRODUCER.

It was piano shaped, measuring 4'H x 5'L x 2'D, plus 405 TABULATOR. Rate was up to 120 cards per minute. Both have been dismantled.

## Reference:

Mr. A. Highley  
Mr. S. Thorne  
Mr. W. Turner

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KRYHA ANALOG

The KRYHA ANALOG (KRYHA DECIPHER) was an improvised electro-mechanical desk-top device to simulate the KRYHA cipher device. It was built in 1942 for Army by Dr. Martin Joos out of whatever materials were available.

The analog used selector switches and relays to simulate the alphabet sliding in the parent device. Ordinary light bulbs served both as resistors and to indicate internal setting. The bulb for the letter J was painted red to remind the operator to punch the key twice. Input was by keyboard and output was to a GXCO regeneration typewriter.

The device measured about 3'H x 3'L x 1'D plus keyboard and typewriter. Rate of speed was very slow. It has been dismantled.

References:

MAC Outlines #36  
Mr. R. Weidman  
Mr. L. Wheatley

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September 1954

## MADAME X

MADAME X (AFSAF 14, AXCQ/1, 003 RELAY BOMBE, ARMY BOMBE), was a relay crib tester or message setter, an exhaustive trial device designed to recover stecker (end-plate wiring), rotor order and window setting for German Army traffic enciphered on a three-wheel ENIGMA machine. In July and October 1943 Bell Telephone Laboratories delivered 144 of the 003 frames, basic units which make up a BOMBE. These used telephone selector switches to simulate rotor encipherment while comparable Navy equipment (AFSAF 23) uses actually spinning one-sided rotors.

A number of special attachments and usages were developed. Two models of the SWISS CRIBDRAGGER (AFSAF 15 & 16) set up in 1945 added circuitry to a set of the 003 frames, extending the BOMBE cribtesting function to crib-dragging. Each model used a different sensing system, permitting a SCRITCHER type testing. The ARLINGTON DUBBUSTER (AFSAF 17), described elsewhere, used the 003 frames in applying a statistical test rather than a crib. Plans for AZALEA and BACHELOR, two suggested versions of a photoelectric HIGH SPEED CRIBDRAGGER (AFSAF 43), were cancelled, as were plans for MONA (N-1100), a one-wheel BOMBE. CLAMBAKE (AFSAF 20) was a GRENADE type message setter. OYSTER SHUCKER was a control attachment to make specialized tests. DOUBLE INPUT (AFSAF 21 and 22, also called CROSSPATCHING or RECIPROCAL BOARDS) two-part menu. FALSE STOP ELIMINATOR (FALSE HIT ELIMINATOR) and a conflict suppressor similar to the Navy SQUELCHER controlled volume of print-outs by adding a secondary test.

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MADAME X (Cont'd)

Each 003 frame was in effect a double ENIGMA cipher machine, and as many frames were used as there were pairs of letters in the menu (crib versus cipher letter pairings), usually about 16. These frames were preset at prescribed setting intervals and all were pulsed to step at once, thus retaining the setting intervals unchanged during a run or test. An electric impulse was sent through successive frames. The reciprocal board, representing possible steckers, furnished a series of return paths through which the current flooded back to other levels of the ENIGMA chain and eventually back to the test relays. At wrong settings, all twenty-six paths would usually have current indicating no true single reciprocal circuit existed. Accordingly the machine stepped to the next setting, continuing through the cycle of  $26^3$  or 17,576 settings, testing all possible stecker assumptions at every setting. When one or more of the test relays failed to get current, the machine stopped and a recording device "printed" a record, a square of points burned onto metal-coated teledeltos paper. Control and recording were housed in one unit called a turrent, located in an adjacent room.

A single frame measured 8'H x 6'L x 1'D and as many such units were interconnected as the problem required. Testing one three-wheel order took 10 minutes, wheel order change required half a second; and a hit was recorded in one second. All 003 equipment, in original or modified form, has been dismantled. It operated at Arlington Hall Station until shortly after World War II in Room 0200-B.

Reference: M.A.C. Outlines No. 9  
M.A.C. Outlines No. 16  
Mr. E. D. Marston

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NAG PL 86-36/50 USC 3605

NAG (AFSAF 105 and 105A, HAGELIN C-38 ANALOG, ELECTRICAL HAGELIN, AXNQ/1) is a relay analog of the HAGELIN C-38 cipher device, and is used mainly for [REDACTED]

[REDACTED] The Army built five of the first model (AFSAF 105) between December 1944 and December 1951. Serial 1 and 2 a second model (AFSAF 105A) were delivered in 1953, and 1954 respectively. ELECTRIC HAGELIN designates the very first analog only; NAG, applied for shop convenience only to the latest two, AFSAF 105A, is already being applied to any and all of the seven. The Navy SATYR (AFSAF 102) is identical in principle and function, but uses the 6 actual pinwheels instead of relays and switches.

Input is by keyboard and tape reader; output is to a CXCO re-generation typewriter. Peg pattern, lug pattern and slide are set up on plugboards and starting point is set by switches. [REDACTED]

[REDACTED] The device is very flexible and often specifically useful [REDACTED] which have a marked predominance of either active or inactive pegs.

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NAG (Cont'd)

Size of the latest pair is 6'H x 3'L x 3'D plus keyboard and typewriter and rate is 6 to 8 characters per second. They are in operation at Arlington Hall Station in room 2208-A.

## Reference:

MAC Outlines No.32  
Completion Report  
Mr. N. Christopher  
Miss B. Church  
Mr. F. Mayol

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September 1954

## NAVY BOMBE

The NAVY BOMBE (AFSAF 23, CXCQ) is a rotor type crib-tester and message setter using electronic and relay circuits to recover stecker, starting point and rotor order by exhaustive trial, given only the rotor and reflector wiring in use in German ENIGMA traffic. U.S. Naval Computing Machine Laboratory working at National Cash Register Company in Dayton built about 140 of all types for Navy, the first arriving in October 1943. This figure includes 100 of the old model N-530, 29 of the now standard N-1530 and various special ones. Also in the family of BOMBES but described separately are the eight FIRE ENGINES (INVERTED BOMBE) and three GRANDDADS (N-800, DOUBLE BOMBE), all variations on the basic models. The earliest experimental BOMBES were labelled N-500 and the very first pair was called ADAM and EVE. Comparable Army equipment was called MADAME X and simulated rotor motion with relays.

A variety of GRENADES was developed to perform limited BOMBE tests by making use of additional information; these are described under that title. Other special auxiliary devices include an M-8 DECIPHERING DEVICE, M-9 HANDTESTER (N-550, N-1800, N-2400 and the associated BOA wheel, N-2300), high-speed M-10 PRINTERS (N-1000-8) a JONES DUBBUSTER, a PRINTER TESTER, a SELF-DETECTOR, a SQUELCHER (CONFLICT SUPPRESSOR) and others.

The Navy machine uses actual single-sided rotors turning at 1725 revolutions per minute to test exhaustively all stecker assumptions against all  $26^3 = 17,567$  or  $26^4 = 456,976$  rotor settings. The correct

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NAVY BOMBE (Cont'd)

setting will differ from all others in that usually one and only one true circuit of the thirteen possible will be set up and only a pair of the twenty-six test relays will receive current. When one or more relays fail to receive a pulse, the machine brakes, backs up to the right point, scans the primary circuits in the menu and then the secondary, if present, makes a printed record of the setting and continues testing. Input is a set of 16 or less crib-versus-cipher letter pairings called a menu, which is set up reciprocally on a plugboard. A STANDARD GRENADE is now built onto every BOMBE.

Testing rate on the Navy machine is 50 seconds for a 3-wheel run or 20 minutes for 4-wheel, considerable faster than the 10 minutes running time needed by MADAME X for a three wheel run. But wheel order change in MADAME X required half a second versus about 10 minutes for Navy, thus resulting in slightly over an hour each for a full test of 6 wheel orders. A Navy BOMBE measures 7'H x 8'L x 2'D and weighs 5000 pounds. A bay of 4 BOMBES and associated wheel cabinets and checking desk requires 600 square feet of space. Four are in use at present at Naval Security Station in room 4174. Thirteen more N-1530 BOMBES and sixteen assorted GRENADES are stored at Mechanicsburg, Pennsylvania; the rest have been dismantled.

## Reference:

CIT papers 11,12,13,28,46,77,88  
 CIT-TS 5,7,16,44,45,46  
 NSA-34 files  
 Mr. C. Higgins  
 Mr. G. McDonald  
 Mr. J. Stapleton

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## NC MACHINES

NC is the abbreviation for "Navy Change" and designates a series of 13 equipments produced locally for the most part by modifying standard IBM equipment. All are now obsolete and dismantled.

The NC-1 was a CONSECUTIVE NUMBERING DEVICE which operated on a 513 REPRODUCER PUNCH to number a deck of cards consecutively. The Mark I model was mechanically driven; Mark II was relay controlled. Speed was 100 cards per minute. In May 1950, NSA-22 built a similar bit of numbering circuitry for the custom-built 797 COORDINATING REPRODUCER (necessitated by its non-standard feed, with 9-edge of the card leading instead of the usual 12-edge), which was also called CONSECUTIVE NUMBERING DEVICE.

The NC-2 was a RELAY ADDER to mechanize decryption of additive cipher, made by modifying a 513 REPRODUCER PUNCH. Size was 4'H x 5'L x 2'D and rate was 100 cards per minute. The NC-4 replaced it.

The NC-3 was a SINGLE ELIMINATOR (CXNA) developed during the war by International Business Machines Corporation for Navy. It was a standard 077 COLLATOR modified to the single function of "de-duping," selecting duplicate cards in a deck and leaving the numerically unique ones. It used vacuum tubes for comparisons over a maximum span of 10 positions. Both of the two highly similar models operated at a rate of 300 cards per minute. The NC-12 replaced it.

The NC-4 was a SELECTIVE PUNCH (Mark I = CXNB, SELECTIVE CROSSFOOTING PUNCH; MARK II = AFSAF 42, CXNT, 797 COORDINATING REPRODUCER), the original ones being a hybrid combination of REPRODUCER elements on an 080 SORTER frame. Its basic improvement lies in the extra set of reading brushes installed between the card feed and punch dies, permitting reading the card one cycle earlier, doing a

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NC MACHINES (Cont'd)

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calculation or substitution and then punching results into the same or a preceding card. This machine and its modifications, described in M.A.C. Outline Number 49, replaced the Army-built PRESENSING PUNCH. Now known only as 797 COORDINATING REPRODUCER, the machine is a versatile work-horse and, when used with various appropriate gates, can do matching, comparing, reproducing, gangpunching, etc. There was also a Mark III with a substitution matrix. An NC-4 VERIFYING UNIT was built by Army in 1947 to indicate errors in the cards compared. Speed is 100 cards per minute.

The NC-5 was a PATTERN PUNCH (CXNC) which, like the NC-4, consisted of REPRODUCER elements and an extra set of reading brushes built into an NC-4 frame. Developed by International Business Machines Corporation for Navy and since returned, it was used to reduce upper text to a pattern of letter repeats within a span of 26. Symmetry search was made of such patternized text to locate isomorphic coincidences between or within sequences. Requiring two cycles per card, its rate was less than 50 cards per minute.

The NC-6 was a COLUMN DIFFERENCER (CXND) consisting of 2 units, a modified 513 REPRODUCER PUNCH and a special accumulator unit measuring 5'H x 5'L x 2'D. It could accumulate up to 400 occurrences within a control group of cards, recognizing the highest frequency digit and punching a record into a summary card. A threshold could be set to ignore low frequency occurrences entirely. One major use was

Speed  
was about one card per second. It is described in M.A.C. Outline Number 19 and has been replaced by a number of other devices.

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NC MACHINES (Cont'd)

The NC-7 was a locally built PERCENTAGE SELECTOR (XEA, PERCENTAGE COLLATING DEVICE) consisting of two units, an O77 COLLATOR used with a 3'H x 2'L x 2'D relay unit to do a wide variety of jobs based on comparison to find partial matches. One use was a round robin comparison of 12,000 cards, selecting cases of two or more occurrences of three or more equal columns. In general, the machine accepted at each cycle a column or field of columns as a standard and matched corresponding column (s) as desired, selecting all cases which equal or exceed a given percentage of coincidence. For instance, all in-phase cases where two (40%) or more out of five columns coincided could be selected. Rate was 100 cards per minute.

The NC-8 was an AUTOMATIC CIRCUIT CHANGER (XEK), a locally built plugboard switching device consisting of a 4'H x 6'L x 3'D relay unit. Usable with almost any card operated machine, its main function was to perform automatic or manual switching of alphabetic or numeric information among as many as 25 plugboards. It had a column arranging feature similar to the COLUMN ARRANGING DEVICE. Manual or automatic control permitted various reproducing, gang punching and interpreting operations. A major use was to accept 10 groups from an original card and insert them group by group with collateral information into a particular field in each of 10 new cards. Rate depended on the particular machine with which it operated.

The NC-9 was to be a SUBSTITUTION PUNCH to be used as an attachment to an NC-4 for performing a predetermined substitution of characters in a reproducing run, but was never built. Some of the planned features were incorporated into the NC-4 MARK II (AFSAF 42).

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NC MACHINES (Cont'd)

Both the NC-10 and NC-11 (CXNG and CXNH) were unimportant IBM rental equipments. The former was a special typewriter and tape device with special keyboards. The latter was a manual or card operated typewriter and involved special alphabets.

The NC-12 (CXNJ) was a modified COLLATOR with no other name than SPECIAL ALPHABETIC COLLATING DEVICE. It was more versatile than the NC-3 SINGLES ELIMINATOR which it replaced. There were plans for a specialized model of the NC-12 to permit proportional control, the job then being done by the NC-7 PERCENTAGE SELECTOR.

The NC-13 was a MICROFILM PUNCH (CXNW, FILM-CARD CONVERTER) consisting of a camera and film handling unit, an optical cabinet and a special high speed 513 REPRODUCER PUNCH. It was developed by International Business Machines Corporation to convert IBM cards to and from 35mm microfilm for ease in storage or shipping. The machine was used in four ways: As the usual card-to-card transfer, for card-to-film or film-to-card conversion, and for verifying a developed film against its source deck. A standard bottle-plug selected which of these functions it would perform. The optical cabinet mounted on the end of a 513 and measured 4'H x 2'L x 2'D. A camera 1'H x 1'L x 1'D mounted atop the REPRODUCER. One frame (a picture of an IBM card) extended 3 sprocket holes, or 9/16". The one model has been returned.

References:

Machine Branch Annual Report 1947  
Mr. G. Kier  
Mr. J. Stapleton  
Mr. F. Fordham

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September 1954

## PALLY

PALLY is a loosely used term, originally applied to a sub-project (352-7210, formerly 351-433) started in 1951 to develop and produce PALLY (AFSAF D97, PLPM, PLAIN LANGUAGE PROCESSING MACHINE, PLAIN TEXT PROCESSING MACHINE) which would read chadless tape, and edit, categorize and convert the data to page copy as separate messages. The name has also been used by some to describe various resulting units, both interim and ultimate. Due to this and the fact that study tasks are also designated by the term, a new term NELLIE has been chosen to designate the final equipment. Its purpose is to mechanize the processing of NSA'S vast volume of intercepted plain text.

Two major functions are required, - format control and categorization. The first is accomplished by recognizing message endings such as time-and-signature groups and accordingly spacing the print output into separate messages. The second is done by recognizing any of a list of words, etc. in text and indicating by a two-digit number which categories of words were found. The problem was at first divided into POLICEMAN, a study task; DEADEYE, a task to develop input devices; MIDWAY, a task to develop a comparing and categorizing unit; and IMAGE, a task to develop the storage and output system.

Of the many tape readers considered as input, the following should be mentioned. The first, called CHADLESS TAPE READER (at one time called AFSAF D97/1, PALLY READER), was a locally built photopneumatic device using

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PALLY (Cont'd)

forced air to lift the chads and scan the tape with photoelectric cells. At about the same time, a chad shearing device called LAWNMOWER (no AFSAF number) was built by NSA-35, to operate with some PALLY READER to form a CHADLESS TAPE READER. It ground off the chads as a preliminary step to photoelectric reading. The former device was dismantled and the latter was stored in favor of an experimental CHADLESS TAPE READER (AFSAF D63) developed by Teletype Corporation, potentially able to read 5 to 7 level chadless tape mechanically at a speed up to 100 characters per second. Parts to build 29 of these experimental readers have been acquired and are being completed by NSA-35.

Format control was experimentally tested by the oddly title PLAIN TEXT RELAY ANALOG (Task 352-419-50-22), constructed locally in September 1951. It successfully recognized time-and-signature groups and inserted spacing between messages accordingly. This device was prototype to a pair of interim devices known as CHUMMY (AFSAF D97A) for operation with CXCO LETTERWRITER and teletype equipment respectively. They were built by NSA-35, the first being delivered in December 1952, and could recognize a maximum of 8 code groups, each 5 to 8 characters long. They were mounted in a typist table and teletype stand and measured 3'H x 2'L x 2'D, with reader and appropriate writer set on top. Speed was 6 to 8 characters per second. They were stored after a short experimental operation period.

BUDDY (AFSAF D97/1) is a somewhat expanded electronic version of CHUMMY, built by NSA-35 for further testing and intended for use in the final equipment. A contract for 6 operational models with relay storage has been let to Ultrasonic Corporation of Cambridge, Massachusetts, with delivery of the first scheduled for February 1955.

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PALLY (Cont'd)

PATRICIA (AFSAF D97/2), the PALLY recognition and categorizing unit, is a storage system and its associated comparison circuitry. It will store the list of words being sought together with respective category designation in readiness for comparison with the data being read. At a coincidence, PATRICIA will set up in a buffer output storage an indication of the category involved and this will be recorded on the output device. Number and size of words and of categories are still under study, so details are not known. One proposal would provide about 2000 groups of 10 characters each, stored on a locally built magnetic drum. As currently planned, a BUDDY and PATRICIA operating together will constitute the final PALLY equipment known as NELLIE.

The original BUDDY relay prototype used a regeneration typewriter for output requiring no storage. A test device (no AFSAF number) using Lake relays for storage and translation was built and tested. It proved less satisfactory than the magnetic binary toroid storage developed for use in the final operational model. Either 407 TABULATOR or an Anderson-Nichols SYNCRO-PRINTER (AFSAF 44B, ALPHA-NUMERIC PRINTER), with printing rates of 300 and 600 characters per second respectively, will probably be used with the final model. As newer printers appear on the market, they will also be considered.

In the final model of NELLIE, the BUDDY unit measures less than 5'H x 5'L x 3'D; PATRICIA will be a bit larger. The size of a CHUMMY was a tape reader and a printing unit (teletype or CXCO regeneration typewriter) set on a typing stand 3'H x 2'L x 2'D into which relays and circuitry were installed.

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PALLY (Cont'd)

Either the 100 character per second speed of the Teletype Corporation mechanical reader (AFSAF D63) or the 200 character speed of the Ferranti reader is the limiting speed, since PATRICIA is designed for 500 characters and the 407 TABULATOR and SYNCROPRINTER operates at 300 and 600 characters respectively.

## References:

T/CA 3/53 Report  
Mr. R. Bronder  
Mr. W. Cole  
Mr. E. Coyle  
Mr. E. Fleming  
Mr. J. May  
Mr. K. Polley  
Mr. J. Russell

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PEELER

PEELER (AFSAF D109, erroneously called HATCHET) is a relay key stripper and crib-tester [redacted] Two such were built, the first by NSA-22 in 1952; the second, a variation of the first, was built by NSA 35, also in 1952.

The first model stores exactly 20 letters of crib set up on plug-board, [redacted] [redacted] or vice versa. Input is two cipher tapes on a TDY double headed reader and output of possible plain is to a CXCO regeneration typewriter. The second, slightly more flexible, is able to recycle a crib of less than 20 letters. Each tests the two messages flush, but offset testing can be done by manual offsetting of tapes.

Both are desk-side strippers aids, measuring 1'H x 2'L x 1'D plus CXCO reader and regeneration typewriter. Rate is 6 to 8 characters per second. They are in use at Arlington Hall Station in room B-2300.

References:

Mr. O. Algren  
Mr. G. Lockhart

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## POLYGRAPHIC COINCIDENCE COUNTER

The POLYGRAPHIC COINCIDENCE COUNTER (AXKQ/1, POLGRAPHIC COINCIDENCE COUNTER AND ALPHABET MIXER, PGGAM) was a relay coincidence counter for

The one model, never used operationally, was completed by Army in April 1946 for use on the PINK problem. It is interesting to note that the Germans built a somewhat parallel device called the POLYGRAPHIC COINCIDENCE GRAPHER.

It consisted of two teletype tape readers, five mechanical counters and a permutation box for 5! or 120 conversion. In a typical problem,

Rate of speed was 6 characters per second.

The permutation box measured about 1'H x 1'L x 1'D. It has been dismantled.

## References:

Completion Report, Project 4-3707  
Mr. F. Mayol

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RICKY

RICKY (XED) was a relay analog for the [ ] cipher machine, and was used for rapid decryption of PINK traffic. Navy built three in 1945, quite similar to the pair of PINK ANALOGS built by Army shortly thereafter.

The device faithfully simulated the original cipher device and served to mechanized the decryption process, once all enciphering variables were known. Input was by tape and output was to a CXCO regeneration typewriter. Both coordinates in the [ ] were pluggable, as were also the wheel patterns.

Size was 4'H x 6'L x 4'D plus tape reader and typewriter and rate was 6 to 8 characters per second. All three have been dismantled.

## References:

Technical Library  
Dr. H. Campaigne~~TOP SECRET FROTH~~~~TOP SECRET FROTH~~

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SCOOTER

SCOOTER (AFSAF DL28) is a relay desk-aid key stripping and handtesting. It was built by NSA-35 and is now being tested before delivery to NSA-71.

In use, from 4 to 40 digits of key (10 tetragraphs or 8 pentagraphs) are inserted in relay storage memory A by means of a special keyboard. A 4 or 5 digit group is inserted in memory B and added to or subtracted from key in memory A. A 10 x 10 matrix performs the arithmetic, non-carrying, mod 10. Matching is possible only in 4 or 5 digit phases. Results are printed out on a quiet adding machine type printer. Dits may be indicated or entire group printed in red. The device can also subtract or add a stream of digits entered by keyboard.

Dimensions are less than 2'H x 2'L x 2'D plus keyboard and printer and rate is 3 lines per second. It will be used at Arlington Hall Station.

Reference:

Mr. N. Christopher

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### SILENT SUZIE

SILENT SUZIE was an/AR relay gate used with a 405 TABULATOR to do cribdragging on Jap Army traffic. It was built by Army in about 1944. SUPER SUZIE, built in 1945, was a later model using two such gates to provide larger capacity. The term was also applied to the patterned cribdragging technique, used mainly for cipher square recovery.

The device used a crib reduced to idiomorphic pattern and compared resulting key patterns (usually non-unique) against the pattern of known key. Cipher text was read from cards and limitations of the current 10 x 10 non-latin-type enciphering square were set on a plugboard. A span of 10 positions was matched at each comparison. This was later increased to 40 positions in SUPERSUZIE. The aim was to locate a sequence of key used to encipher a given message of known plain code.

An AR gate measures 2'H x 2'L x 2'D. Used with a TABULATOR, the device processed 150 cards a minute, producing about 700 to 1000 comparisons. They were modified rental equipment and have been discontinued and returned to International Business Machine Corporation.

References:

Mr. A. Highley  
Mr. J. Powers

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## TAPE COMPARATORS

The term TAPE COMPARATOR is a general term, though used at times as a specific title. It designates equipments which compare or combine tapes of any sort, including those machines whose sole function is to transfer data in unaltered or at most mono-enciphered form plus some card and keyboard operated equipments and a few computational devices with minor additional functions. Typically, the tape referred to is the 11/16" teletype tape, or the 7/8" CXCO LETTERWRITER tape, known as punched paper tape. Others, such as 70mm paper tape (2 3/4 inches wide) and any of the various magnetic tapes, may also be considered in this category. The following tape comparators are described elsewhere under their own title: CONNIE, DECIMATOR, DELLA, GOLDBERG, IDA, JOHN, LDM, MATTHEW, ROBIN, VIVIAN and the 70mm COMPARATOR. Many substitution and deciphering devices could also be included under this term.

Equipments not handled separately are described here under one of the four following families: (a) COMPARATOR (b) COMBINER (c) VERIFIER or (d) PATTERNIZER. The ambiguities obvious in these captions will be removed, it is hoped, by the definitions and descriptions which follow:

(a) TAPE COMPARATOR or TAPE COMPARER refers loosely to a family of devices for matching tapes in search of certain properties such as baud, character or group repetition, with the text in explicit or in pattern form. No single unique term exists to designate this most important class, since TAPE COMPARATOR may properly if ambiguously refer to all four families, or to only this first, or to the third family alternately known as VERIFIERS. Typically, data is read in from two tapes and indication is given in some manner when a required similarity or dissimilarity is found. CONNIE or ROBIN is a clear example.

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## TAPE COMPARATORS (Cont'd)

Section GAS-74 of Army, under project 4-3721 built a device in September 1947 for the PINK problem known only as TAPE COMPARATOR and often confused with CONNIE I, which originally was named only TELETYPE TAPE COMPARATOR (M.A.C. Outline Number 56). It was a double-headed tape reader with the Christmas tree (relay translator) unit replaced by a resistor network under control of feeler-pin contacts. The device combined pairs of characters from 2 tapes, baud by baud with like signs canceling. Output through an external Christmas tree was typed out in usual Baudot equivalents on a CXCO regeneration typewriter. Rate was 6 to 8 characters per second and size was negligible. It has been dismantled.

A pair of TAPE COMPARATORS (no AFSAF number), completely similar in principle, have been built by NSA-35. One is in use in room 2315-A and the other in 2050-B. Each contains 5 counters and a settable threshold control mechanism. Speed is 6 to 8 characters per second.

Navy dropped plans in August 1944 for OPHIDIA, a general purpose photo-electric double-tape comparator which was to match data punched into 70mm polystyrene tapes, doing weighting and summing in a manner similar to the

Also canceled at about the same time were plans for SERPENT, a generalized OPHIDIA.

In 1947 Navy also built a novel but nameless comparator, essentially a double-headed reader which stopped when character coincidence occurred and marked the location on the tape. A COLOR CONTROL REGEN was built consisting of a double-headed reader and regeneration typewriter, arranged to print out either tape with coincidences in red and non-coincidences in black.

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## TAPE COMPARATORS (Cont'd)

(b) The TAPE COMBINER family includes any TAPE DIFFERENCER, KEY COMBINER, KEY STRIPPER or DECIPHERER where key is supplied by tape or where two tapes are combined to produce a third. This may be done by characters or bauds according to some particular rule of addition, differencing or arbitrary substitution. Usually, two values produce a single result. MATTHEW or any deciphering device using key tapes is an example.

In October 1945 and January 1946, Navy built a pair called MOD 2 DEVICE or MOD 2 ADDITIVE MACHINE flexible enough to combine characters by bauds, with the 7 levels interchangeable by plugboard control. They are used to take a difference between 2 tapes or a delta of text, for which an additional counting function is added. Size is negligible and rate is 6 to 8 characters per second. They are in use at Naval Security Station in room 4152.

A pair of equipments was built by Army in 1948, also for 7-level, and each was called MOD 2 DEVICE. Visual binary counters furnished totals of plusses and minuses for each level. Selection of levels to be matched as well as the rule of addition or combination to be followed were plugboard controlled.

Four CXCO TAPE COMBINERS were built by Army, one in October and December 1947 and a pair in May 1948. Each used a doubled-headed CXCO reader, a plugboard for selecting elements to be combined, switches to eliminate levels and a bank of relays to combine baud levels. Output was to a CXCO regeneration typewriter of tape punch.

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TAPE COMPARATORS (Cont'd)

Dr. Martin Joos of Army designed and built or supervised the building of several equipments falling in this category, some of which are: ADDITIVE DECIPHERER, [redacted] DECIPHERER, GLA DECIPHERER, and the SWISS PAGE-COLUMN-LINE DECIPHERER. No records and data are available on them except that they were tape operated and resembled the JMA DECIPHERING MACHINE in operation. All were quite small and inexpensive, with obvious functions.

F Branch of Army built a pair of the HORIZONTAL DIFFERENCER in June 1946 (project 4-3712). These used 14 relays to difference adjacent punches in 5 level tape, punching a new tape of the resulting delta pattern. Size was 1'H x 2'L x 2'D and rate was 6 to 8 characters per second. The GXCO DELTA COUNTER (see M.A.C. Outlines Number 46), was also Army-built and did the same job, adding a counting function.

(c) The TAPE VERIFIER family, also called TAPE CHECKER or COMPARER, is not truly analytic, serving only to check accuracy of data in tape by matching two typings of text and indicating any disagreement. Though numerous, they are unimportant to analysts except for the accuracy factor. Many of them never acquired a name and left no clear record.

Under project 6-5701, Army section GAS-76 built a TAPE VERIFIER (M.A.C. Outline Number 58) in September 1947 to do the usual checking job for two tapes or a tape and a retyping, showing errors by a lighted lamp. The end product was a new tape, punched at 6 to 8 characters per second.

## TAPE COMPARATORS (Cont'd)

A TAPE PUNCH VERIFIER (AFSAF D67) was built by NSA-35 in 1951 for ATLAS and DEMON tapes, as was also a 25-POSITION DEMON PUNCH CHECK (AFSAF 77/10), both for very specialized purposes. CENSOR (AFSAF D70/10) is for ATLAS and DEMON tape too, and checks accuracy of the insert-and-check-address sequences of characters, which are 6th and 7th level punches. It is a CXCO equipment and operates at 60 to 100 characters per second.

A pair of devices, called simply TAPE CHECKERS, was built in <sup>1951</sup> 1951 to match characters read in by a double-headed CXCO reader, stopping when a difference in text is found. It operates at 60 to 70 characters per second. A pair of AFSAF 25 photoelectric tape readers has been set up with common drive to check a tape or pair of tapes by counting total punches. This arrangement acquired no name or designation.

The PRE-PUNCH VERIFIER was built by NSA-35 in 1952 to assure accuracy of 5-level tape punching. It stored in relays 50 characters typed on a keyboard, and matched these against a retyping, the keyboard locking at an error. A hand correction permitted the typing to continue. The 50 characters were then punched into tape automatically at 10 strokes per second.

(d) The term PATTERNIZER refers to a family of machines which is clearly named and functionally defined by the name. Reduction to pattern may consist of sorting characters into classes such as into vowels and consonants or into odd and even parity. It may also be based character idiomorph or repetition, with or without regards to positional value in text or in the alphabet. The patternizing may apply to bauds, to characters or to groups of characters. AYE-AYE and MILLIE are good examples.

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TAPE COMPARATORS (Cont'd)

Navy built a TAPE PATTERNIZER (XFN) in 1949 of no great importance. Reduction to parity in this manner is often accomplished by plugboard in standard CXCO LETTERWRITER equipment. The biggest need in this whole field of TAPE COMPARATORS is adequate nomenclature. For this reason, in spite of extensive research, it is possible that some of the above titles may be synonymous.

References:

CIT Paper No. 64  
GSA Model and Type Designation List  
MAC Outlines No. 46 and 58  
Mr. O. Algren  
Mr. N. Christopher  
Mr. J. Powers  
Mr. J. Russell  
Mr. J. Stapleton

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## TAPE-TO-CARD REPRODUCER

The TAPE-TO-CARD REPRODUCER (AFSAF 111) is a relay device using a double-headed tape reader and a 519 REPRODUCER to transfer text from tape to card one character at a time and to take a delta statistic in the process. Two such devices were built by Army, section WDGAS-92, in 1948.

Transfer of information to cards is done in usual fashion, but relays are used to take a delta count (ratio of change to no change) by baud levels between two tapes or between characters in one of the tapes. Results are punched into the new cards along with the text being shifted (offset), one new character per card.

The device measures 2'H x 3'L x 3'D, has a tabletop to support the double-head tape reader and attaches to a 519 REPRODUCER. Rate is 100 cards per minute. One was dismantled. The other is available at Arlington Hall Station in room 1700-A but is little used because, in effect, the TAPE INDEXER supercedes it.

## Reference:

Mr. S. Thorne

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### TRANSPOSITION DECIPHERMENT DEVICE

The TRANSPOSITION DECIPHERMENT DEVICE (AXEB/1) was a standard O40 TAPE-TO-CARD PUNCH, modified to control transfer of text to cards, breaking it into prescribed column lengths. Section WDGAS-92 of Army made the modification in 1949.

Using 3 relays and 2 stepping switches controlled by plugboard, the device counted the number of characters being inserted into a card interrupted punching after a specified number of characters, ejected the card and repeated the process as often as needed. This could be repeated for a double transposition. The process, which usually ended with a sort and print, was used successfully to test key or text on various widths for periodicity. A keyboard could also be used to insert the text.

Rate of operation was about 500 characters a minute. Size was 3'H x 4'L x 3'D. It has been dismantled.

#### References:

Machine Branch Annual Report 1949  
Mr. S. Thorne

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September 1954

## 702 EDPM

The 702 EDPM (ELECTRONIC DATA PROCESSING MACHINE, TPM, TAPE PROCESSING MACHINE) is an electronic computer with design emphasis on mass data handling, similar in many respects to NOMAD. It is being developed by International Business Machine Corporation to be offered for rental, perhaps as early as May 1955. The major features of the machine are its very large volume input and output, especially suited to sorting, collating and similar processes.

A 10,000 character electrostatic memory is the principle storage and consists of cathode ray tubes having cycle time of 23 microseconds and an access time of 8 microseconds per character. There are two accumulator registers each with a 512 character capacity. As many as 30 magnetic drums are also available, each having 300 addressed locations holding 200 characters per location, or a total of 1.8 million characters. Reading rate is 40 microseconds per character. Up to 100 magnetic tape reels ( $10\frac{1}{2}$ " diameter, 2400' long, each holding the contents of 25,000 IBM cards) serve as another type memory, or as input-output. Such tape is read at a rate of 67 microseconds per character using a pulse rate of 15 KC. Reverse speed is 500 inches per second. The units may be combined independently in any desired way, permitting simultaneously operation in many instances.

All computation is done serially in the ALU (the arithmetic and logical unit) and stored in memory. Data is coded decimally and converted automatically to binary for internal use. There are 36 orders available and a one-address system is used. The machine automatically accommodates

702 EDPM (Cont'd)

its operation to variable word length, the 511 usable positions of accumulator storage being the factor setting the upper limit. Programming, which is fairly simple, makes plugboards unnecessary. Several automatic checking features on the accuracy of machine operation and computation have been provided.

Punched cards, punched tape, magnetic tape, typewriter or line printer may be used for input and output. As many as 100 card readers, 100 tape units, 100 card punches, 100 type 407 TABULATORS and 30 drums may be used. Peripheral conversion equipment makes all these readily interchangeable. Cards are read at 250 per minute and punched at 100 per minute. Basic pulse rate is 15 KC. Physical size will be large. It will probably be the first machine with high-speed large voltage input and output (a 400 line per minute wire printer is being developed for the equipment). It should be faster at look-up, etc. than the computers, but the MAYBE equipment and others computer auxiliaries will change the picture.

**Reference:**

IBM Manual, 702 ELECTRONIC DATA PROCESSING MACHINE  
Mr. J. Hyduke  
Mr. J. McPherson  
Mr. J. Powers