

VARIETIES OF BALANCED WORDS, PART 3

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This is the third and final part of a three-part article discussing varieties of balanced words; the first two appeared in the August and November 1997 Word Ways. For the sources of words used, see Part 1.

Start from the centre of a word (i.e., from a space if the word has an even number of letters, and from a letter if an odd number). Work outwards, noting the position of each letter, counting 1 for each space and 1 for each letter. Thus ABLE has letters at positions 1 and 3 on either side of its centre, and BAKER has letters in positions 2 and 4. Multiply the position of each letter by its position in the alphabet (its weight). Add the products ("moments") to the left of centre, and separately those to the right. If these two results are equal, the word would balance about its centre, as the moments tending to make the word rotate anti-clockwise are balanced by those which make the word rotate clockwise. For example, AZURE has anticlockwise moments of $4 \times 1 + 2 \times 26$, and clockwise moments of $2 \times 18 + 4 \times 5$. Since both equal 56, AZURE balances about the U.

J A LINDON'S WORK

Such words were termed CBB or Centrally Balanced Beam words by J A Lindon in the February 1969 Word Ways. He actually used a different set of weights for words with an odd number of letters (1,2,3...), though this makes no difference to balancing or not, and we will make use of this system below. The method above always gives a distance of two between adjacent letters, whereas his method gives a distance of one or two depending on whether the word has an odd or even number of letters. Regarding terminology, I prefer "momentous" as it is shorter--and punny. However, I shall use "momentous" for words that balance about any letter or space, and use "CBB" as in the past for the subset of momentous words which balance about their centres (though I would prefer just CB). Lindon went on to make many interesting points, which will exemplify with real words (sometimes, I believe, for the first time).

1. All CBBs with fewer than four letters are palindromes (easily seen).
All CBBs of even length must have an even number of letters with even weights. As (in Lindon's system) the position or weight of a letter is always odd, multiplying that by an even or odd weight gives respectively an even or odd moment. Firstly, suppose one side to have an odd moment (WASSA-ILERS): it must have an odd number of letters (5) with odd weights. The other side must balance so has an odd total moment, which must likewise be due to an odd number of

letters (3) with odd weights. Hence the whole word has an even number of letters (8) with odd weights. But we said the whole word has an even number of letters, so the other type of letters (those with even weights) must appear an even number of times ($10-8 = 2$). Secondly, suppose one side has an even moment (UNAME^NABLY): if it has any letters with odd weights, they must appear an even number of times (4). The other side must have an even moment to balance, so likewise has an even number of letters with odd weights (2). The word therefore has an even number of letters with odd weights, and (as it has an even number of letters in all) therefore it must have an even number of letters with odd weights ($10-6 = 4$). The examples were a little difficult to find, as over 80 per cent of even-length CBBs have the same number of letters with odd weights on each side. Actually, the biggest difference between the number of odd letters on the two sides is 4 (5:1, 2:6 or 3:7): HYPOTH^YMISMS, KOMMA^NDANT, LEPTOTH^RICOSES and SPLANCHN^OSCOPIES.

2. In every CBB of five letters, the pair of letters adjacent to the pivot are either both odd or both even. For example, in AZURE, R is 18 and Z is 26, both even. On each side, the moment of the outer letter is even, since its weight is multiplied by its position of 2. The moment of the inner letter (its weight multiplied by 1) is odd or even according as the letter weight is odd or even. Hence the total moment of that side will be odd or even according to the weight of the inner letter. For the two sides to balance, the weights of the inner letters must therefore have the same parity.
3. Balance is unaffected if equal weights are added or subtracted at equal distances either side of the pivot. The ultimate example of this is when all letters are shifted the same amount (for example, when COLD becomes FROG, both CBBs). More examples are given later.
4. A CBB having the same sum of letter weights on each side is called EW (Equal Weight). For example, SCORNER has letter weights of $19+3+15$ on the left and $14+5+18$ on the right, both adding to 37. However, such words have been called (Double) Numerical Tautonyms, so we shall refer to them as DNTs. All palindromes are DNTs. Asymmetrical DNTs must have at least six letters. For example, taking the 5-letter word abcde, the CBB property states $b+2a = d+2e$, and the DNT property states $b+a = d+e$, which requires $a = e$ and $b = d$, so the word has the palindromic form abcba. The two halves of any DNT may be reversed and the word will still be CBB and a DNT (Lindon quotes SCORNER and OCSRREN, not a word so far as I know). I found just ten 4-letter word pairs and three 6-letter word pairs which are both DNTs and have reversible halves (see list later); unfortunately they are all palindromes. See my later remarks under Templates.
5. Double tautonyms with up to six letters (like TOM-TOM) can only be CBBs if they are double palindromes (like TUT-TUT). In fact, double tautonyms must contain an even number of letters, and those with two or four letters can only be momentous if all four letters are identical. Other examples of length six include MAM-MAM and PIP-PIP.
6. Lindon defines CBB Doublets as CBBs in which each half is CBB, giving the neologism LOIN-TAMP as an example. I found about 2.3 per cent of the CBBs had CBB left halves, and about 3 per cent had CBB

right halves. About 0.9 per cent of CBBs are doublets (excluding words with fewer than four letters, which must qualify). Many doublets (indeed, all doublets of even length that I found) consist of the same group of letters repeated, with or without a central letter (for example, POROPORO). Naturally, some of those are palindromes such as NANNAN. Others have palindromic halves, such as ELEVATA, NONOSES, NONUSES. (The reasons for this are given in Templates.)

Lindon shows how to use the theorems above, and others, to create new DNT CBBs. I found that about 11 per cent of CBBs with four letters or more are DNTs, i.e., about 0.1 per cent of dictionary words. Lindon's article goes into more detail, and explains how to find momentous words by using paper strips or a frame and slider.

CALCULATION OF CENTRE OF GRAVITY

Actually, in finding the words that follow, I did not use the method above, but rather the more general approach introduced by Charles Bostick in "Word Weights" in the May 1974 Word Ways. Starting from the left, we simply number the letters 1,2,3... then multiply each of these numbers by the position of that letter in the alphabet. Adding the results gives the combined moment about a pivot placed one position to the left of the leftmost letter. We now divide this number by the sum of the letter weights. This gives the Centre of Gravity of the word. If this is in the centre of the word, then the word is CBB, and it is in the centre if, when divided by one more than the length of the word, the result is one-half. If this last division produces exactly a whole number, or a whole number and a half, then we have a balanced word of a more general type (see next section). For example:

	A	Z	U	R	E	
Position	1	2	3	4	5	
Weight	1	26	21	18	5	sum = 71
Product	1	52	63	72	25	sum = 213

Centre of Gravity = $213/71 = 3$ (at U). Balance is at position 3 of the word. AZURE is CBB. Normalised Centre of Gravity (NCG) = $CG/(length + 1) = 3/6 = 0.5$. Balance is halfway along word.

Bostick threw out challenges to find words with the largest and smallest CGs, and the largest and smallest normalised CGs. I have taken these challenges to refer to CGs which appear exactly at a letter or a space.

I found that about 0.6 per cent of dictionary words are CBBs, and 0.9 per cent balance about other positions. I give some examples later.

TEMPLATES

When restrictions such as those mentioned above are enforced, a word is no longer free to contain any letters it likes. I show the effect of

some restrictions in the table below, using a,b,c... to represent any letters. The more complex arithmetic restrictions of CBBs cannot be shown in this manner, but some can. Take, for example, 6-letter words consisting of a double (letter) tautonym. The essential structure of all such words is abcabc, where the letters in the most special case are all the same, but in general all different. If we now force this to be a CBB, the anticlockwise moments must equal the clockwise moments: $5a+3b+c = a+3b+5c$. This leads to $a = c$, so b may be any letter, but c must be the same letter as a, so we find in the table abaaba. All such words must have this palindromic form. Examples have been given in the most general form if they have been found:

	CBB	CBB and tautonymic	CBB doublet
2	aa (AA)	aa (AA)	aa (AA)
3	aba (EWE)	aba (EWE)	aba (EWE)
4	abcd (ARID)	aaaa (ZZZZ)	aaaa (ZZZZ)
5	abcde (BIPED)	aabaa (OOL00)	aabaa (LLILL)
6	abcdef (CUDGEL)	abaaba (KAKKAK)	abacdc
7	abcdefg (ALIGNED)	abacaba (OGOPOGO)	abacded(PAPISTS)

OOL00 is found in Funk & Wagnalls Unabridged, and LLILL in Pughe. This table should not be read as allowing complete freedom of choice, since, for example, once you have chosen abcdef in a 7-letter word, the seventh letter is determined for you (and perhaps no letter will serve to balance the word). As is clear, there is no distinction between the types of words below four letters.

Up to length 8, all CBB doublets must be DNTs. Giving an example of length 6, the CBB property for the word abcdef requires $5a+3b+c = d+3e+5f$. The doublet property forces $a = c$ and $d = f$. Together they imply the word is of the form abacdc, and $2a+b = 2c+d$. But this last makes the word a DNT. As the table shows, for lengths of 2 and 4 CBB doublets must be double letter tautonyms (tautonyms in the normal sense having a group of letters repeated). For longer words we still have only three equations for ever more letters, so the choice of letters is less constrained. For lengths 6 to 8, as just illustrated, the CBB doublets must be DNTs, although all I found were the more restrictive letter tautonyms. For length 9 and up, the equations bite less fiercely, and CBBs do not have to be DNTs but the letters still have to obey restrictions. For length 9, $a+2b+3c+4d = 4f+3g+2h+i$. Nevertheless, these bite sufficiently that I found only traditional tautonyms for lengths 9 and 10 (allowing ABBADABBA as a tautonym for the sake of argument). Length 11 produces a word that is still DNT but not a traditional tautonym, and length 12 finally produces words that are neither.

To distinguish clearly between double numerical tautonyms and the common tautonym, let us call the latter DLTs (for Double Letter Tautonyms). Note that, in the table above, all CBBs which are also DLTs are CBB doublets. This we will now demonstrate as a new law. Consider the length 10 double letter tautonym abcdeabcde. We calculate the centre of

gravity (taking moments about the left as $7a+9b+11c+13d+15e$ divided by $2(a+b+c+d+e)$, and this equals 5.5 for balance at the centre. This condition simplifies to $4a+2b-2d-4e = 0$. Notice that c has disappeared, which happens for words of 2,6,10... Now make the half of the word, $abcde$, balance about its centre: $a+2b+3c+4d+5e$ divided by $a+b+c+d+e$ must equal 3, which leads to $2a+b-d-2e = 0$, exactly the same equation as before. A tautonymic CBB must be a CBB doublet. You will reach the same conclusion if you repeat the calculation for odd or even lengths. In the case of odd lengths, the central letter disappears from the first equation, and is never entered into the second equation, so there are no restrictions on it.

The central letter of one half does not always disappear as did the c in the worked example. The disappearance of one of the letters from the equation happens because the doublet balances about that letter, so the value of the letter is of no concern. This happens when half the word is of odd length, for then there is a central letter to the half. Hence, there is no restriction on the central letter of each half of a doubly tautonymic CBB doublet of twice an odd length.

The table does not deal with the combination DNT-CBB. Such words of lengths 3 to 5 must be of the form aba , $abba$ and $abcba$, respectively. For lengths 6 and greater, the form is not dictated, but the restrictions become: $2a+b = e+2f$, $2a+b = f+2g$, $3a+2b+c = f+2g+3h$, $3a+2b+c = g+2h+3i$, $4a+3b+2c+d = g+2h+3i+4j$, and so on. The simplest solutions to these equations are rather tautonymic, the first letter equalling the last, etc.

The table also does not display ALV-CBB combinations. The equations are not very restrictive, and I did not find an example which was a CBB doublet.

If the two halves of a CBB are reversed, and the resulting word is CBB, then both words are DNTs. For example, $abcdef$ is CBB if $5a+3b+c = d+3e+5f$. Exchanging a for c and d for f gives a similar equation. Adding the two gives $a+b+c = d+e+f$, the condition for a DNT. This is true for all lengths.

CBB DOUBLETS

Note that all the even length CBB doublets are tautonyms (DLTs). This does not have to be the case: from above, in the case of length 6 it is sufficient that $2a+b = 2c+d$. Again, the preference of people (speaking various languages) for repeated sounds is evident. However, these are all DNTs. Unfortunately I was unable to find any CBB double doublets, as the minimum length for a non-trivial example is 16 letters.

Length 4: AAAA (Tahitian interjection), MMMM (ATHS), OOOO (Roget), ZZZZ (ATHS)

Length 5: AASAA (Cooper: An Archaic Dictionary), EELEE (F&W), LLILL (Pughe), LLULL (Catalan writer), OOLOO (F&W NSD), OOPOO?, OOROO (James Thurber), SSESS, ZZZZZ (W70-252)

- Length 6: ANAANA (F&W NSD), KAKKAK, MAMMAM, NANNAN, PIP-PIP, TAT-TAT, TUTTUT, WAW-WAW, WOW-WOW
- Length 7: ELEVATA, NONOSES, NONUSES, OGOPOGO, PAPISTS
- Length 8: BILABILA (W69-041), BORABORA (W69-041), DIRADIRA (W69-041), KEEK-KEEK, LIRILIRI (W69-041) NETINETI?, PEEP-PEEP, PILOPILO (W69-041), POROPORO, RIRORIRO, TURUTURU
- Length 9: ABBADABBA (W78-212)
- Length 10: COUCICOUCI (Roget)
- Length 11: HYPERGNOSES, HYPERINOSES, SECONDLEVEL?

Examples of CBBs with their left halves also balancing: ATAXIC, ARAMINA, DIDDLED, POPLARS, TITFERS, TITTERS, FROGFISH, ARRANGING, ASSAILING, LAVENTINE, PLUMELESS, TAYLORISM, FRATERNATE, FRATERNIZED, HYPERURESIS, MODERNISING, GYNOMONOECIOUS?, PSEUDOSPERMIUM. Examples of CBBs with their right halves also balancing: COFF, MILL, CLIFF, CLUFF, KNELL, KNOLL, WHIRR, ZEISS, BENDED, MOSSES, MYASIS, TENNON, TENSES, THESES, WRESTS, ALEMANA, KRYPSIS, LOTUSES, REVISES, UTMOSTS, OVERWENT, DEBOUCHED, PAUPIETTE, MIRABILITE, VAGOTOMIES, ARCHITECTED, DIP SWITCHES, IMPERSSARIO?, SHOESTRINGS, ARCHPRELATIC, COLDPRODUCING?, STERILIZATIONS, BROMOIL TRANSFER?, SUBCOMPENSATION.

CBB DNTS

If we extend the concept of equal counts of letter values in each half of a word to all the dictionary words, then DNTs of length 4 or more are about three times as common as ALVs, which in turn are more than six times as common as DLTs (tautonyms). Therefore I found a lot of DNTs (763) which are also CBB, and indeed 77 that balance about a letter or space at another point. Here is a selection of words which are both CBB and DNT, just selecting the commoner words where there are many. The number in brackets indicates the total number found.

- Length 1: A, B, C...
- Length 2: AA, BB etc
- Length 3 (186): AGA, AHA, BIB, BOB, BUB, DAD, DID, DUD, EVE, EWE, EYE, GAG, GIG, MOM, MUM, NAN, NUN, PAP, PUP, SAS, TNT, WAW, WNW, YAY, YOY
- Length 4 (62): ABBA, BEEB, BOOB, DEED, ELLE, KEEK, KOOK, NOON, OTTO, PEEP, POOP, SEES, TOOT
- Length 5 (116): ALULA, ANONA, CIVIC, DEWED, KAIKAK, KAJAK, KAYAK, KAZAK, LEVEL, MADAM, MARAM, MINIM, QAZAQ, RADAR, REFER, ROTOR, SAGAS, SERES, SEXES, SHAHS, SOLOS, STATS, TENET, ULULU, YARAY
- Length 6 (84): BRILLE, DEGGER, HANNAH, JOKISH, MARRAM, PERPIN, PIGDOM, PRONTO, PULLUP, REDDER, SERMON, SUCCUS, TERRET, TUT-TUT, WARNIS
- Length 7 (91): AMPUTEE, DEIFIED, DURESSE, FANGLED, HADADAH, HILLOCK, MINKISH, MINXISH, NATUREL, PIGGIER?, PILSNER, RACECAR, REPAPER, REVIVER, ROPEWAY, ROTATOR, SCORNER, TANGLER, TENTFUL
- Length 8 (47): AMATRICE, BOREHOLE, EXEMPLAR, FISHTAIL, FIVELING, MEDUSIAN, ONE-LINER, PREDELAY, QUESTERS, RIBCAGES, SICKENER, STINKPOT, SUPPORTS, THERMION, UNLEARNS

- Length 9 (50): ANAPNOEIC, ATOMISING, CARPATHIA, CROSSWIRE, FLAPHINGE?, GRAPPLING, INTERJOIN, ISOCHIMES, MALAYALAM, MNEMENICS, MNEMONICS, OVERCOOKS, OVERLOOKS, OVERSTEPS, PIP-PIP-PIP, PLETHORAS, PRANCINGS, PURVEYORS, ROTAVATOR, SEQUESTER, SLANDERER
- Length 10 (25): ERYTHROSES, FRILL SHARK, GILLNETTED, INCRUSTATE, KETONIZING, KOMMANDANT, NOMINATURE, STARCHIEST, TRAVELATOR, UNAMENABLY, WASSAILERS
- Length 11 (20): CLINOSTATIC, EPICEREBRAL, HYPERGNOSES, KINNIKINNIK, MEADOW CRAKE, NECROMETRIC, PLUMMETLESS, SPINNINGTOP?, TRAVELLATOR, WARDRAIPPER
- Length 12 (6): PREMALIGNANT, SHERARDIZING, SUPEREARTHLY, TATTARRATTAT
- Length 13 (12): ANTHROPONOTIC, CHLOROMYELOMA, CLINOSTATIC, HEMATOSPERMIA, INDIVIDUALISE, PYODERMATOSIS, ROUNDING ERROR, TARAMASALATAS
- Length 14 (6): NEURANAGENESES, NEUREPITHELIUM, PROCHEILICALLY, RACHIANALGESIA, UNINTERMITTENT
- Length 15 (4): GLOUCESTERSHIRE, INTERPHENOMENON, PERDURABILITIES?, SUNFLOWER YELLOW
- Length 16 (3): MUSCEGENETICALLY, OCCIPITOSPHEOID, SELFPERPETUATING
- Length 17 (3): CYCLOMASTOPATHICS, CYSTODIVERTICULUM, MOLECULAR GENETICS
- Length 18 (1): PHRENICOABDOMINALS

CBB DNTS WITH REVERSIBLE HALVES

Length 4: AKKA/KA AK, AMMA/MA AM, ANNA/NA AN, ATTA/TA AT(EDD), BOOB/OB BO, ELLE/LE EL, ESSE/SE ES, OPPO/PO OP, OTTO/TO OT, SUUS(suus heres = heir)/USSU

Length 6: LITTIL(vf)/TILLIT (vf), RATTAR/TARRAT(EDD), RETTER/TERRET

CBB WORD CHAINS WITH ALL LETTERS SHIFTED AN EQUAL AMOUNT

As noted above, shifting all letters by the same amount does not change the CBB property. Words of length 6 that can be shifted are quite rare, and can only be shifted once. There are 30 pairs of length 5; no word can be shifted more than once. Almost 100 pairs of length 4 exist, but some of these pairs join up, as some words can be shifted three times (making a chain of length 4). I found over 600 pairs of length 3; many of these join up in chains up to 11 long, but the words themselves are mostly uninteresting, some being acronyms, etc. A selection of pairs of length 3: AIA MUM (hiya, mom), AKA HRH (not any more, Diana), AVA TOT (what's yours?), ETE TIT, EWE WOW (ram's delight), HEH DAD, HEH LIL, IWI MAM (short Kiwi parent), MUM SAS (militant mum), PDP MAM (computerised parent), PEP TIT, PUP DID (clean it up!), SOS WSW, TIT APA (All Points Addressable!), TOT AVA (Gardner's daughter), WAW KOK. The longest chains with CBBs of length three are:

- 11 ANA BOB ERE HUH IVI NAN OBO PCP? RER VIV (personal name) YLY
- 10 ABA CDC? DED EFE (Web3) HIH NON OPO STS? TUT YZY
- 10 AZA BAB CBC EDE FEF? IHI ONO? POP TST UTU
- 9 ALA DOD EPE HSH (BIW) ITI NYN PAP TET XIX (number)
- 9 ATA BUB EXE HAH IBI (Roget) LEL OHO PIP WPW?

- 8 ACA CEC GIG IKI? MOM NPN SUS YAY
 8 AHA BIB ELE HOH IPI NUN OVO TAT
 8 ARA DUD EVE HYH NEN OFO? ULU WNN?
 8 AUA EYE GAG ICI (French or corporation) MGM OIO (town, NZ) TNT YSY

Length 4 pairs (selected from 29)

AFFA OTTO	ALLA TEET	ARRA NEEN	ATHE BUIF
ATTA LEEL	AUIE (vf) SMAW	AUUA (DMLR) KEEK	AVVA (EJ) TOOT
AZZA (location, Iran) POOP		CLOB FORE	COLD FROG
CURD WOLX	DORC GRUF	DWTE SLIT	ELOD TADS
ESSE MAAM	FADE TORS	FICH LOIN	FILE LORK
HIFI NOLO	IMMI KOOK	JAPE NETI	NASH REWL

Length 4 triplets:

ACCA EGGE SUUS (suus heres = heir)	ADDA BEEB LOOL
AIIA (personal name, NZ) EMME GOOG	AMMA GSSG? SEES
APPA (language, CIWL) PEEP TIIT (DJE)	AROB DURE RIFS?
AYYA (cape, Crimea) ECCE USSU	BROC RHES SIFT
CRUB PEHO TILS	MILL PLOO SORR

Length 4 quadruplets:

AAAA (Tahitian interjection) MMMM (Roget) OOOO (Roget) ZZZZ (ATHS)
AHHA (surname, Paris) BIIB (PED) ELLE TAAT (EDD)

Length 4 quintuplets:

ABBA DEED NOON OPPO TUUT (in Russia)
ANNA BOOB ERRE NAAN OBBO

Length 5 (selection from 29 pairs):

ALULA - TENET	ANANA - HUH-UH	ANONA - REFER
ATOLE - UNIFY	BIKED - RYAUT	CLIFF - FOLII
CRONE - SHEDU	DELED - STATS	CORKE - WILEY
GRIVE - PAREN	KAJAK - SIRIS	DRIPE - GULSH
PELOK - SHORN	REPAT - VITEX	DUZAN - HYDER
		NOMES - TUSKY
		PAVEN - TEZIR

Length 6:

ANA-ANA (F&W NSD) - NANNAN	HALLAH - LEPPPEL (EDD)
STAATS (Roget) - TUBBUT (EDD)	

MOMENTOUS WORDS

For the purposes of this section, simply number the letters in a word 1,2,3... from the left. Every word will balance about some point, but we will only be interested in those that balance exactly at a letter or space. In theory, a word may balance anywhere from the first space to the space before the last letter. I found the following numbers of words with the balance points as shown for the given word lengths. In *Making The Alphabet Dance*, Ross Eckler quotes the longest known CBB as ANID-IOMATICAL, with 13 letters; the table shows there are 234 of this length and 265 longer, many from Webster's Second. The longest from Webster's Second seems to be UNINTELLIGIBILITY (17) and ANATOMICOPATHOLOGIC (19). The longest two overall are 25 letters long (though two 26-letter words balance at the nearest letter to the centre).

In the table on the next page (split into two parts for legibility), the lengths of the words run across and the positions of the fulcrums run downwards. Note that the central point of a 4-letter word is at position

2.5, not 2; that of a 5-letter word is at position 3, and so on. Therefore, CBB words (balancing at their central point) run diagonally: 26,21,186,196 664,415,824,355,729,275,428... (For 4-letter to 11-letter CBBs, Lindon's corresponding numbers are 37,112,80,153,44,1,1,1.) Words that balance one-third of the way along (position 1.5 for a 3-letter word, position 2.5 for a 6-letter word, etc.) lie on a line that may be traced through the entries 21, 25 and 5. Likewise, words that balance two-thirds along their length lie on a line through the entries 29, 42 and 7. Notice how very few words balance within the first third or last third of a word. Only words that are a multiple of 3 in length have one-third or two-thirds distances lying precisely on a space or a letter.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	26	0	0	0	0	0	0	0	0	0	0	0	0
1½	0	21	21	6	0	0	0	0	0	0	0	0	0
2	0	0	186	153	15	1	0	0	0	0	0	0	0
2½	0	0	29	196	134	25	1	0	0	0	0	0	0
3	0	0	0	158	664	368	82	9	0	0	0	0	0
3½	0	0	0	11	157	415	223	61	5	0	0	0	0
4	0	0	0	0	39	406	824	477	119	11	2	0	0
4½	0	0	0	0	0	42	247	355	189	69	14	0	0
5	0	0	0	0	0	2	101	490	729	372	112	15	3
5½	0	0	0	0	0	0	5	64	228	275	164	35	7
6	0	0	0	0	0	0	0	16	140	386	428	204	61
6½	0	0	0	0	0	0	0	0	7	68	117	135	60
7	0	0	0	0	0	0	0	0	1	16	102	227	234
7½	0	0	0	0	0	0	0	0	0	0	12	38	74
8	0	0	0	0	0	0	0	0	0	0	1	13	71
8½	0	0	0	0	0	0	0	0	0	0	0	0	8
Total	26	21	236	524	1009	1259	1483	1472	1418	1197	952	532	518

	14	15	16	17	18	19	20	21	22	23	24	25	26
6	8	0	0	0	0	0	0	0	0	0	0	0	0
6½	14	1	0	0	0	0	0	0	0	0	0	0	0
7	117	28	2	0	0	0	0	0	0	0	0	0	0
7½	66	20	6	2	0	0	0	0	0	0	0	0	0
8	110	106	28	10	0	0	0	0	0	0	0	0	0
8½	23	35	30	18	3	0	0	0	0	0	0	0	0
9	8	34	40	39	8	2	0	0	0	0	0	0	0
9½	2	4	9	15	7	5	1	0	0	0	0	0	0
10	1	1	1	15	12	9	5	0	0	0	0	0	0
10½	0	0	1	3	2	5	2	2	2	0	0	0	0
11	0	0	0	0	3	6	7	2	1	0	0	0	0
11½	0	0	0	0	0	0	2	1	0	0	1	0	0
12	0	0	0	0	0	0	0	1	2	1	0	0	0
12½	0	0	0	0	0	0	0	0	0	0	1	0	0
13	0	0	0	0	0	0	0	0	0	0	0	2	0
13½	0	0	0	0	0	0	0	0	0	0	1	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	349	229	117	102	35	27	17	6	5	1	2	2	2

Examination of the table reveals that normally there is a big difference between even-length words and odd-length ones. In general, more words of a given odd length balance about their centres than any other point (sometimes, than all other points), but for words of a given even length the point of balance is more often at the two letters immediately adjacent to the centre space. Unremarkably, the number of momentous words increases steadily to a peak at word length 7, then tails off gradually. The percentage of words of a given length that are momentous starts at around 4 per cent at lengths 2 or 4 (length 3 is exceptionally high), slowly decreasing to about 1 per cent at length 13.

The words that balance most to the left (as a fraction of their length) are YUGADA balancing at position 2 out of 6 (remember, one-third is position 2.5), then ULMACEA? at 2.5/7, followed by STICTIDACEA? and WRONGHEADED at 4/11, then jointly 15 words including PEBA, RADA and VEDA at 1.5/4 and SMACKDAB and UNPEACED at 3/8. Bostick asked for words with the smallest Centre of Gravity; these are clearly the single-letter words A,B,C etc. Next smallest are the 48 with a CG at 1.5, also not very interesting. He also asked for words with the smallest normalised CGs (those in which the CG divided by (length+1) is minimum). This is a very similar question to that answered at the start of this paragraph: YUGADA still wins at 0.286, then the 1.5/4 words at 0.3, then the 2.5/7 words at 0.313, then equally the 3/8, 4/11 and 2/5 words at 0.333. (I did not mention the 2/5 words, of which there are 15 like SNEAD, YERBA and ZARAB.)

Those balancing closest to the right (as a fraction of their length) are: firstly, at 3.5/4, eleven words or acronyms such as ABIT, ACES, ADAR, BAAN, BAER, BAHU, BALY, CAAS and CAGY; secondly, at 2.5/3, 29 words or acronyms like ABE, AMP, BAG, COX, DAM, FEW and HAY and jointly at 5/6 the wonderful pair ABBEYS and ABBESS; thirdly, at 4/5, 39 words such as ABASH, BAKES, BECKS, CAJOU, CANNY, CANDY, FAERY-- and a quadruplet DECAY, DECOY, DECKY and DECRY in which only the letter at the fulcrum varies, leaving the balance undisturbed. Bostick asked for words with the largest Centre of Gravity. I found two with a CG of 14, PANCREATICODUODENECTOMIZED and ELECTROCARDIOPHONOGRAPHIES. The runner-up, with a CG of 13.5, will be found in the list below. He also asked for words with the highest normalised CGs (those in which the CG divided by (length+1) is minimum). The 5/6 words come first at 0.714, then the 3.5/4 words and the 7/9 word BACCARATS at 0.7. Third at 0.688 are the 5.5/7 words ACHATRY, ADAGIOS, BAD DEBT, BE-BEAST and CABARET, and fourth are the 6/8, 4/3, 8/11 and 10/14 words, scoring equally at 0.667 (for examples, see the following list).

- 1, 1-1: X
- 2, 1½: AA
- 3, 1½-2½: MAD, MUM, AIL
- 4, 1½-3½: PEBA, QUID, SCUM, ACHE, ACES

- 5, 2-4: STEAD, MIMED, **MINIM**, ACUTE, ADMIX
- 6, 2-4½: YUGADA, *TABBED*, TOPPLE, **USABLY**, ABOUND, *BABBLE*
- 7, 2½-5½: ULMACEA?, USEABLE, WRESTLE, **ALIGNED**, ASHTRAY, CADENZA, CABARET
- 8, 3-6: GOIABADA, TWINKLED, UNAVOWED, **WINGLESS**, ARGUMENT, ADROITLY, BANALITY
- 9, 3½-7: *UNSOLACED*, PROSCRIBE, SHATTERED, **SLAUGHTER**, BRISKNESS, CATCHMENT *FADDISHLY*, BACCARATS
- 10, 4-7: PYROMANIAC, SMOULDERED, STRAIGHTEN, **SWEATINESS**, ANTAGONIZE, CHIEFTAINS, FLACCIDITY (or BAKED BEANS!)
- 11, 4-8: WRONG-HEADED, UNTOUCHABLE, WATERLOGGED, WHEREWITHAL, **COMMISERATE**, COMPOSITELY, DELINQUENTS, DIFFIDENTLY, ACCIDENTARY
- 12, 5-8: UNEXPLICABLE, UNFATHOMABLE, APPROPRIATED, **CRYPTOGRAPHY**, ECONOMETRICS (or EAU-DE-COLOGNE), GRACEFULNESS, ACCELERATIVE
- 13, 5-8½: UNSUCCEEDABLE, UNLIQUEFIABLE, INEXPERIENCED, RECONCILIATED?, **REHABILITATED**, APPREHENSIBLY, APPLICABILITY, BEARDLESSNESS
- 14, 6-10: UNRESTRAINABLE, FLUVIOVOLCANIC, NEUROCHEMICALS (or GREAT SLAVE LAKE), **STERILIZATIONS** (or ROYAL TANK CORPS), DESTRUCTIONIST (or CRADLESNATCHERS? or BREAD AND CHEESE), INCARNATIONIST, FALLACIOUSNESS, BACKHANDEDNESS, BACCHANALIANLY
- 15, 6½-10: SHOWYGAILLARDIA?, COUNTERFEITABLE, EXPERIMENTARIAN, **MERCURIFICATION** (or GINGERBREAD TREE or GLOUCESTERSHIRE), BIOASTRONAUTICS, DISEMBARKATIONS, BENEDICTIONALLY, DECAPACITATIONS
- 16, 7-10: TYPOLITHOGRAPHIC, SUPERSIGNIFICANT, PSYCHOLINGUISTIC, **SELFPERPETUATING**, DISINCORPORATION, DICHOTOMIZATIONS (or BELLS AND WHISTLES), PACHYDACTYLOUSLY
- 17, 7½-10½: PHYTOSOCIOLOGICAL, NONCORRESPONDENCE, INTERPOPULATIONAL, **UNINTELLIGIBILITY** (or WALL-TO-WALL CARPETS or AVOIRDUPOIS WEIGHT), PALEOPHYSIOGRAPHY, MALADMINISTRATIVE (derived), ABDOMINOJUGULARLY
- 18, 8½-11: POLYCHROMATOPHILIA, PARALLELOGRAMMICAL, **UNDERNUTRITIONALLY** (or **FREQUENCY HISTOGRAM**), MICROCALORIMETRICS (or QUADRATIC EQUATIONS), BIBLIOTHERAPEUTICS, CEREBELLOMEDULLARY
- 19, 9-11: PSYCHOPNEUMATOLOGIC, TETRAMETHYLDIARSINE, **PHOTOCONDUCTIVITIES** (or **BATTLE OF THE ATLANTIC**), MICROPRECIPITATIONS, ANTICOMPLEMENTARITY
- 20, 9½-11½: THROMBOELASTOGRAPHED, HYDRODIPSOMANICALLY, **PROMEGALOBLASTICALLY**, INTELLECTUALISATIONS?, DENOLIPOMATOTICALLY
- 21, 10½-12: THORACOPNEUMOPLASTIED, **OVARIOHYSTERECTOMIZES** (or **SUBLIMINAL ADVERTISING**), GASTROJEJUNOCUTANEOUS, CHLAMYDOBACTERIACEOUS
- 22, 10½-12: TRIFLUROMETHYLTHIAZIDE, OCULOPLETHYSMOGRAPHICS, (no example), APPENDICULORADIOGRAPHS
- 23, 12: **MICROSPECTROPHOTOMETRIC**
- 24, 12½-13½: **PHARYNGOLARYNGECTOMIZING**, (no example), CARBOANGIOCARDIOGRAPHICS
- 25, 13: **UVULOPALATOPHARYNGOPLASTY**
- 26, 14: ELECTROCARDIOPHONOGRAPHIES

The list on the previous page contains just one sample word for each point of balance for a given length of word. The range of balance points is given after the word length in the heading. For example, samples of 15-letter words are preceded by 15, 6 $\frac{1}{2}$ -10, meaning that one sample is given for each balance point from positions 6.5 to 10, i.e. 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10. Words balanced at their midpoints are in bold, and words balancing one-third or two-thirds along are in italic (note that I found no such words for lengths greater than nine).

OTHER CBBS

The following list gives further examples of words that are balanced about their centres (CBB words). Specialised examples have already been given in the lists for CBB DNTs, CBB words with all letters shifted an equal amount, and in the list immediately above. Words with an odd number of letters remain balanced when the central letter is changed, such as in LICEN, LIFEN, LIMEN, LINEN, LITEN, LIVEN. Words which duplicate those in previous lists are only used where there is no alternative (as for QAZAQ).

4: AXLE, BRIE, COFF, DOLE, EILD, FETA, GIRD, HIRE, IMAM, JETE, KURL, LAVE, MICO, NORM, ONER, PLUM, QUOS, ROUP, SIFT, TAMP, USSU, VOIX, WENT, YETT, ZZZZ

5: AVINE, BOTCH, CRANE, DRAPE, ELAND, FETID, GROVE, HYPER, IMBUE, JURAT, KNELL, LINEN, MOWER, NAVEL, OVENS, PIPER (or PEPSI), QAZAQ, RIVET, SLURP, TAPER, UNAPT, VALET, WHIRR, XENO'S or XANAX (Pharmaceutical), YHURT, ZINKY

6: AVOWAL, BYPATH, CUDGEL, DECADE, ENOUGH, FLORAL, GENERA, HALTED, IMPURE, JUDGES, KNAWEL, LAWMAN, MINUTE, NAMING, OCULAR, POISON, QUATRO, RATHER, SIGNET, THESES, UNWILY, VELVET, WEAPON, YARRUM

7: ASTOUND, BESEECH, COMBINE, DILEMMA, ENQUIRE, FORBORE, GENERIC, HEROINE, INTERIM, JERKING, KINSMEN, LIBERAL, MOTIVES, NULLIFY, OBVERSE, PADLOCK, QUASARS, ROSIEST, SUBVERT, TRANSIT, UNBUILT, VIBRATO, WARRANT, YAUPERS, ZOOCYST

8: AMICABLE, BROILING, CAVILLED, DOWNLINK, ECSTATIC, FLUORITE, GEORGIAN, HORNBOOK, INHALING, JUNCTION, KILLDEER, LOCALISE, MAGNETIC, NEBULATE, ORNAMENT, PEARLING, QUADRANT, ROOMIEST, SPOOKILY, THEORIZE, UNDERLAY, VERNIERS, WALLOPER, XENOGAMY, YEARNFUL

9: ALGEBRAIC, BOBSLEIGH, CIVILIZED, DISCLOSED, EFFLUENCE, FETTUCINI, GEOSPHERE, HURRIEDLY, INTUITION, JUMPERISM, KARYOSOME, LIBIDINAL, MARGARINE, NARCISTIC, OTOLOGIST, PETROLEUM, QUINOLOGY, RETARDANT, SOLEMNIFY, TREATMENT, UNDERTOOK, VAPORISES, WHITENERS, XEROPHILY, YETIFLIRT?, ZONARIOUS

10: ARBITRATED, BOURSOCRAT, CRINGELING, DRUMFISHES, EXACTITUDE, FRATERNATE, GnosticISM, HOMECOMING, INVOCATION, JOURNAL BOX, KETONIZING (or KITE FALCON), LATINISTIC, MOROSENES, NOMINATION, OENOPHILES?, PRIMITIVES, QUADRUPLES, REINFORCES, SCREWBALLS, TITILLATOR, UNFAITHFUL, VAGOTOMIES, WHISPERERS, YEARETHLYE, ZEALOTRIES

11: AVOCATIONAL, BURLESQUING, COMMINGLING, DISPLEASING, EPISTEMOLOG (or ELBOW-GREASE), FRIGHTENING, GRANULATING, HEMISPHERAL, INVALIDATES, JOURNALIZES, KININOGENIN, LIQUIDATION, MISDERIVING, NECROBIOTIC, ORIENTATION, POLITICALLY, QUASIBRONZE?, ROGUISHNESS, SEISMOMETER, THWARTSHIPS, UNNERVINGLY?, VULCANOLOGY (Star Trek?), WHISPERLESS, XANTHICALLY

12: ARCHPRELATIC, BIOGENETICAL, COCCULINELLA, DUCHENNEARAN?, EVOLUTIONISM, FLUORIDATION, GYNAECOCRACY, HOMEOPATHICS, INTROMISSION, JUDGMENTRATE?, KECKLE-MECKLE, LACTOPROTEID, MERRYTHOUGHT, NEPHROPYOTIC, OVIGENICALLY, PERPLEXITIES, QUADRIVALENT, REINTUBATION, SUBSCAPULARS, TRANQUILLEST, UNDERCLOTHES, WAGGONWAYMAN

13: ANOREXIGENICS, BRACHYCHEILIC, CONTAMINATING, DEPROTEINIZED, ENTEROSCOPICS, FORMULAICALLY (or FREE ASSOCIATE), GENTLEMANHOOD, HYDROBORATION, INCOMPETENCES, JOHNSONIANISM?, KERATOTOMIZED, LAY DOWN THE LAW, METEMPSYCHOSE, NUMERABLENESS, ORTHOPAEDISTS, PREJUDICIALLY, QUASICUSTOMER?, REPULSIVENESS, SCHOOLBOYHOOD, THANATOLOGICS, UNREMITTINGLY, VARIOLOIDALLY, WHARTONITISES

14: ARTERIOPATHIES, BUREAUCRATIZED, CONDYLOTOMIZED, EXSANGUNITIES, FULLER'S THISTLE, GEODEMOGRAPHIC?, HYPERSPLENISMS, INTEROMEDIALY, LEPTOTHRICOSES, MAZOPATHICALLY, NASOTRACHEALLY, OVERSTRIDENTLY, PEPSIGOGICALLY (teaching about cocaine?), QUILTING COTTON, RACHIANALGESIA, SPODIOMYELITIS, TRACHEOPATHIES, UNDRAMATICALLY, WASTEFULNESSES

15: AUTOKINETICALLY, BROMOIL TRANSFER, CIRCUMSTANTIATE, DEPROVINCIALIZE, ERISOPHAKICALLY, FAMILY PHYSICIAN, GLYCOSIALICALLY, HYPERCHROMATISM, INTERINHIBITION, KINESITHERAPIES, LARYNGOSPASTICS, METEPENCEPHALON, NONPYRITIFEROUS, OVERBLESSEDNESS, PROGNOSTICATORS, QUALIMETRICALLY, REINTERROGATION, STENTORIOUSNESS (or STICKING PLASTER), TUBERCULIZATION (or THREE PIECE SUITE), UNSTEADFASTNESS, WHIPPERSNAPPERS

16: ALVEOLARARTERIAL, BIOROENTGENOGRAM, CONTRAVERSIALISM?, DERMATODYSPLASIA, ENTEROTROPICALLY, FUNDUSECTOMIZING, GRANULOCORPUSCLE, LARYNGOSTENOTICS, MACROSPLANCHNICS, OVERCONTRIBUTION, PROREVOLUTIONIST, RETICULOTOMIZING, SPHINCTEROSCOPES, TRANSILLUMINATOR, UNACKNOWLEDGMENT

17: AUTOHEXAPLOIDALLY, COUNTERHYPOTHESES, DIHYDROPENICILLIN, ESOSPHEOIDITISES, GASTROMEALICALLY, HYPERALIMENTATION, LYMPHOIDECTOMIZES, MOLECULAR GENETICS, NEUROAPILLITISES, ORGANOMEALICALLY, PHOTODENSITOMETER, QUASICONVERSATION?, SUPRACLAVICULARLY, THOUGHTLESSNESSES, UNADULTERATEDNESS, WALL-TO-WALL CARPETS

18: FREQUENCY HISTOGRAM, GASTROMYXORRHEALLY, MICRORADIOGRAPHIES, PHRENICOABDOMINALS, STERNOCLAVICULARLY, UNDERNUTRITIONALLY

19: ANATOMICOPATHOLOGIC, BATTLE OF THE ATLANTIC, DERMATOHOMOPLASTIED, GONIODYSGENETICALLY, GONIODYSGENETICALLY, MICROREFRACTOMETRIC, PHOTOCONDUCTIVITIES, SCHIZENCEPHALICALLY

20: PODODYNAMOMETRICALLY, PROMEGALOBLASTICALLY

21: OVARIOHYSTERECTOMIZES, SUBLIMINAL ADVERTISING

23: MICROSPECTROPHOTOMETRIC

24: PHARYNGOLARYNGECTOMIZING

25: NEPHROCYSTANASTOMOTICALLY, UVULOPALATOPHARYNGOPLASTY

MOMENTOUS WORDS (INCLUDING CBBs) WHICH ARE ALSO (DOUBLE) TAUTONYMS

As the following list shows, most (34 out of 49 words of length 4 or more) momentous tautonyms are CBB. Recall also that momentous tautonyms up to 4 letters long must have identical letters, and tautonymic CBBs of lengths up to 6 must have two palindromic halves. Words that are not CBB are preceded by ^. As proved earlier, all the CBBs here must be CBB doublets, and (as Lindon said) all up to 6 letters long must have palindromic halves.

Length 4: AAAA, MMMM, OOOO, ZZZZ

Length 5: AASAA, EELEE, LLULL, OOLOO, OOPPOO, OOROO, SSESS, ZZZZZ

Length 6: ANAANA, ^BOUBOU, ^COXCOX, ^GABGAB, KAKKAK, ^KHAKHA, MAM-MAM, NANNAN, ^PAEPAE, PIP-PIP, TATTAT, ^TEETEE, TUTTUT, WAWWAW, WOWWOW

Length 7: OGOPOGO

Length 8: ^ALUNALUN, ^BERIBERI, BILABILA, BORABORA, ^CHANCHAN, ^CHINCHIN, DIRADIRA, KEEKKEEK, LIRILIRI, ^MOKAMOKA, NETINETI, PEEPPPEEP, PILOPILO, POROPORO, RIRORIRO, TURUTURU

Length 9: ABBADABBA

Length 10: ^ANDOLANDOL, COUCICOUCI, ^MUNGEMUNGE, ^SHACKSHACK

MOMENTOUS WORDS (INCLUDING CBBs) WHICH ARE ALSO ALVs (WORDS WITH AN AVERAGE LETTER VALUE OF 13.5)

I found 65 of these. Those preceded by * are also CBB; those preceded by § are also BLPs (words consisting solely of pairs of letters, each pair adding to 27). None are CBB doublets.

Length 4: AWEY, *§AZZA (Iran), BORS?, HILY, *§LOOL, *PION, *SIFT, *THEU, TORA, §VOLE, YOCK

Length 6: BOULEZ (composer), CONTEX, COPLOT, COSETS, CRIPPS?, DISNUN, GIPSEY, JARULS?, KILEYS?, MID-SKY, PORTIC, RUNMAN, SKYGOD?

Length 8: ARGENTRY, CORRANTS, *FOOTWELL?, *LILYPINK?, OTOPHONE, FIGFULLY, *SEVENSES (= FANTANS), *SOLLIDLY, TROPHICS, TRUNCALS, TRUTH-LED?, *§VALORIZE, *VENNESON, *WHIPCROP?, *WINGLESS

Length 10: ASPERSIONS, CONJURATOR, FOOT FAULTS, HUMIFEROUS, MUMMYAPPLE?, PEASOUPERS (of fog), PREDESTINY, SKYSCRAPER, SURREALISM, WHIPSTITCH

Length 12: *FRONT OF HOUSE, INFINITYPLUG?, MAMMOTOMIZES, MISPRONOUNCE, PTOMATROPINE, *SMOKINGOPIUM?, STRAWPLAITER?, WESTERNISING?

Length 14: ALLYLESTRENOLS, HYDROXYLACTONE, POLYNUCLEOTICS, URETHROSCOPICS

Length 16: *LARYNGOSTENOTICS, *RETICULOTOMIZING, *SPIROCHETOLYTICS, *TRANSILLUMINATOR

CBB TRIPLETS

Following the definition of CBB doublets, we may divide a word with $3n$ letters into three parts, and require that each part, as well as the whole word, has the CBB property. The word abcdefghi must have the form abacdcefe (triply palindromic) to satisfy the first requirement, thus making it an Agamemnon word as defined by Ed Wolpov in the May 1980 Word Ways. By a similar argument to the one used in the Templates section, $2a+b$ must equal $2e+f$ to satisfy the whole-word CBB requirement. There are 7332 combinations of values of a, b, e and f that fill the bill; multiply this by 26×26 to get all cases of c and d , and we have nearly five million sets of 9 letters. Unfortunately, even a huge dictionary is not likely to list as many as 90,000 of the 26^9 possible 9-letter combinations of nine letters as words--less than one in 60 million. So our chance of finding a valid word seems to be 1 in 12. Thanks to the predilection for repetitive sounds in English, I found PIP-PIP-PIP and TAT-TAT-TAT (ignoring the trivial case of 3-letter CBBs, which all qualify).

Stretching the definition a little, we might permit cutting the word down the centre of two letters, so that the 8-letter abcdefgh has to be CBB, and the parts ab, de and gh have to be, implying that the word looks like aabccdee, where $12a+5b = 5d+12e$. In this sense, all words of length $3n+2$ may be examined. However, apart from the trivial exception of 5-letter CBBs, which all qualify, I found no such triplets of any length.

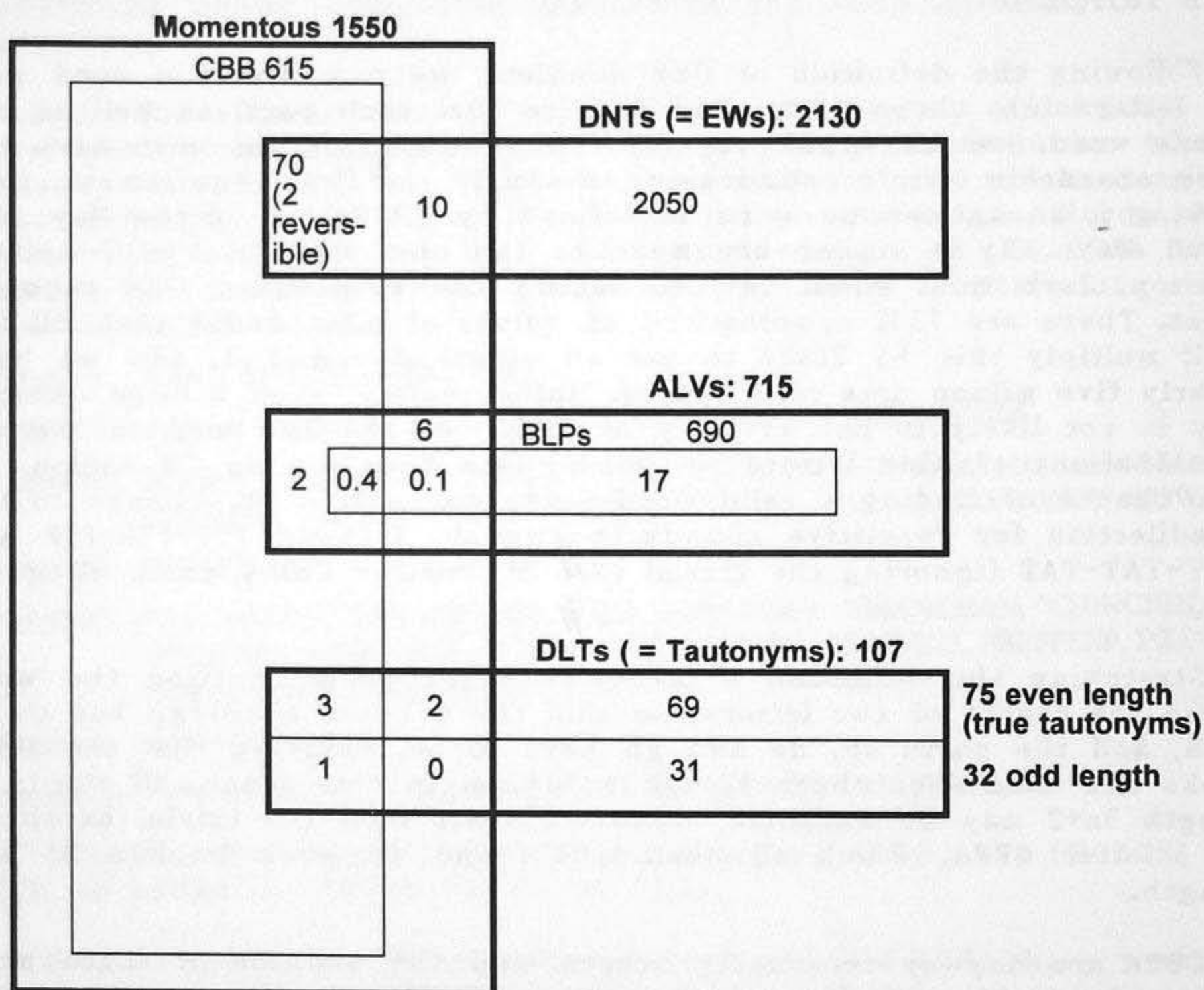
CBBs are anyway reasonably scarce, and the addition of three more constraints makes finding short words unlikely. As the words become longer, the constraints bite less severely, but the supply of CBBs runs out. It would be more profitable for me to open a book on which Word Ways contributor first finds a non-trivial example of 12 letters or more!

SOLUTION TO PROBLEM IN PART 1

VALORIZE is the only word of a reasonable length (more than four letters) I found that is CBB, and also one of the subset of ALVs that are BLP (has balanced letter pairs); gratifyingly, it is not a tautonym or 2-letter palindrome. VOLE is also unique, in that it is BLP (hence also ALV) and is momentous, but not CBB (it balances about the 0). For another challenge, find a word to cause the removal of the zero in the figure on the following page.

ACKNOWLEDGEMENT

Many thanks to Susan Thorpe for supplying historical Word Ways information and for discussing her article on ALVs (she also wrote a story using many ALVs in the February 1995 Word Ways). I clearly owe a debt too to Jeff Grant, Richard Sabey and other Word Ways contributors.



Number of each category of word (length 4 or more)
per hundred thousand dictionary words

For example, there are about 8.5 words of length 4 or more per hundred thousand dictionary words which are ALVs and momentous; of these, 0.5 are BLPs, split into 0.4 which are momentous and CBB, and 0.1 which are momentous but not CBB.

CBB DOUBLETS

There are no CBB doublets among the words which are CBB and ALV (whether BLP or not). All the words which are CBB and DLT must be CBB doublets. All the CBB doublets that exist (nearly 6 per hundred thousand dictionary words) are to be found among the CBBs which are also DNT (though none are among the CBBs which remain CBBs when their halves are reversed).