The **flushend** package

Sigitas Tolušis
`sigitas@vtex.lt`

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1 Introduction

The package is used to balance columns on any page in twocolumn mode. By default it is switched on at the end of document. It is expected to work with footnotes, top floats and column break before one line section title.

2 Usage

Just load the package to balance the last page: that's all. To balance some page in middle of document use command `\flushcolsend` at that page.

`\flushend`

This macro switches on column balancing on the last page. It is used by default.

`\raggedend`

This macro switches off column balancing on the last page.

`\flushcolsend`

This macro switches on column balancing on the current page.

`\raggedcolsend`

This macro switches off column balancing on the current page.

`\atColsBreak` {⟨*tokens*⟩}
Adds ⟨*tokens*⟩ in place of the original column break (made without balancing).

Example: `\atColsBreak{\vskip-2pt}`

`\atColsEnd` {⟨*tokens*⟩}
Adds ⟨*tokens*⟩ at the end of right column.

Example: `\atColsEnd{\vfil}`.

`\showcolsendrule`

It can be used just for debugging: adds rule to the bottom of columns.

2.1 Package options

ancient	It is used to switch on old version of balancing algorithm.
modern	It is used to switch on new version of balancing algorithm.
autobase	It is used to guess `\baselineskip` value on original columns break. On failure just use `\atColsBreak{...}`.
noautobase	It is used to switch off the previous option behaviour.
spread	It adds extra glue to the rightcolumn trying to balance.
nospread	It skips adding extra glue to the last column.
removelastbox	It tries to remove an empty box (some more material) from the last column bottom.
keeplastbox	It skips removing anything from the last column.
debug	Adds rules to the bottom of columns (just for debugging) and leftcolumn break place. Adds some additional log info.
nodebug	Skips putting debuging lines.

3 Implementation

```
1 \newif\if@auto@baselineskip \@auto@baselineskiptrue
2 \newif\if@ancient@balance@version \@ancient@balance@versionfalse
3 \newif\if@right@column@spread \@right@column@spreadtrue
4 \newif\if@remove@lastbox@at@balancing \@remove@lastbox@at@balancingtrue
5 \newif\if@balance@debug \@balance@debugtrue
6 \DeclareOption{autobase}{\global\@auto@baselineskiptrue}
7 \DeclareOption{noautobase}{\global\@auto@baselineskipfalse}
8 \DeclareOption{ancient}{\global\@ancient@balance@versiontrue}
9 \DeclareOption{modern}{\global\@ancient@balance@versionfalse}
10 \DeclareOption{spread}{\global\@right@column@spreadtrue}
11 \DeclareOption{nospread}{\global\@right@column@spreadfalse}
12 \DeclareOption{removelastbox}{\global\@remove@lastbox@at@balancingtrue}
13 \DeclareOption{keeplastbox}{\global\@remove@lastbox@at@balancingfalse}
14 \DeclareOption{debug}{\global\@balance@debugtrue}
15 \DeclareOption{nodebug}{\global\@balance@debugfalse}
16 \ProcessOptions

17 \newskip\flushend@@lastskip@a
18 \newskip\flushend@@lastskip@b
19 \newskip\flushend@@lastskip@c
20 \newcount\flushend@@penalty@a
21 \newdimen\flushend@@lastkern@a
22 \newdimen\var@@temp@spread
23 \newdimen\var@@temp@a
24 \def\top@@skip@@limit{.7\topskip}
```

```
25 \newdimen\flushend@@page@rule \flushend@@page@rule\z@
26 \def\showcolsendrule{\global\flushend@@page@rule=.4pt}
```

\top@@floatbox@min {⟨*float size*⟩} This value is used to catch possible float on right column top.

```
27 \gdef\top@@floatbox@min{4\topskip}

28 \newbox\flushend@@varbox@a
29 \newbox\flushend@@varbox@c
30 \newbox\flushend@@tempbox@a
31 \newbox\flushend@@tempbox@c
32 \@ifundefined{@viper}{\newbox\@viper}{}
33 \@ifundefined{hold@viper}{\newbox\hold@viper}{}

34 \newtoks\atColsBreak \atColsBreak={}
35 \newtoks\atColsEnd    \atColsEnd={}

36 \@ifundefined{fmt@box@adds}{\def\fmt@box@adds#1{#1}}{}
37 \@ifundefined{fmt@vbox@adds}{\def\fmt@vbox@adds[#1]#2{#2}}{}
```

\remove@lastbox@at@balancing It is used to remove empty box at the right column end.

```
38 \def\unskip@three@kern@penalty{%
39   \unskip\unkern\unpenalty
40   \unskip\unkern\unpenalty
41   \unskip\unkern\unpenalty
42   }
43 \gdef\remove@lastbox@at@balancing{%
44   \unskip@three@kern@penalty
45   \bgroup
46     \setbox\z@\lastbox
47     \ifdim\wd\z@>\z@
48       \box\z@
49     \else
50       \aftergroup\unskip@three@kern@penalty
51     \fi
52   \egroup
53   }
54 \AtBeginDocument{%
55   \if@remove@lastbox@at@balancing
56   \else
57     \let\remove@lastbox@at@balancing\relax
58   \fi
59   }
```

Macros used in debug mode.

```
60 \def\show@@box#1{%
61   \bgroup
62     \showboxbreadth=20000\showboxdepth=20000%
63     \showbox#1\relax
64   \egroup
65   }
66 \def\wlog@balance@debug#1{\if@balance@debug \wlog{#1}\fi}
```

```
67 \def\log@box@info#1{<box\the#1>(\the\ht#1+\the\dp#1)x\the\wd#1}
68 \let\show@@box@next\@gobble
```

To get more or less proper result we need to know about footnotes at the left column end, top floats at the right column top, skips and so on. This part of the package is responsible for such analysis.

```
69 \gdef\analyze@lastbox@box#1{%
70     \setbox\flushend@@varbox@a\vbox{%
71         \unvbox#1%
72         \global\flushend@@lastskip@a\lastskip
73         \unskip
74         \global\var@@temp@a\lastkern
75         \unkern
76         \global\flushend@@penalty@a\lastpenalty
77         \unpenalty
78         \ifdim\lastskip>\z@
79             \global\flushend@@lastskip@a\lastskip
80         \fi
81         \unskip
82         \ifdim\lastkern>\z@
83             \global\var@@temp@a\lastkern
84         \fi
85         \unkern
86         \ifnum\lastpenalty>\z@
87             \global\flushend@@penalty@a\lastpenalty
88         \fi
89         \unpenalty
90         \global\setbox\flushend@@tempbox@a\lastbox
91         }%
92     \wlog@balance@debug{^^J::analyze@lastbox@box::\log@box@info{#1}%
93         ^^J ::unvbox: \log@box@info{\flushend@@varbox@a}%
94         ^^J::lastbox: \log@box@info{\flushend@@tempbox@a}%
95         ^^J::lastskip: \the\flushend@@lastskip@a;
96             lastkern: \the\var@@temp@a;
97         lastpenalty: \the\flushend@@penalty@a
98         }%
99     }
```

\analyze@leftcolumn@box   {⟨box⟩}

```
100 \gdef\analyze@leftcolumn@box#1{%
101     \splittopskip\z@ \vfuzz\maxdimen \vbadness\maxdimen
102     \flushend@@lastskip@b\ht#1%
103     \wlog@balance@debug{^^Jmainbox: \log@box@info{#1}}%
104     \setbox\flushend@@varbox@a\vbox{%
105         \unvbox#1%
106         \global\flushend@@lastskip@a\lastskip
107         \unskip
108         \global\flushend@@lastkern@a\lastkern
109         \unkern
110         \global\flushend@@penalty@a\lastpenalty
```

```
111        \unpenalty
112        \global\setbox\flushend@@tempbox@a\lastbox
113        }%
114    \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
115    \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@a
116    \wlog@balance@debug{.-box: \log@box@info{\flushend@@varbox@a}%
117        ^^J.-lastbox: \log@box@info{\flushend@@tempbox@a}%
118        ^^J.-lastskip: \the\flushend@@lastskip@a;
119            lastkern: \the\flushend@@lastkern@a;
120         lastpenalty: \the\flushend@@penalty@a
121        ^^J.-diff: \the\flushend@@lastskip@b
122        }%
123    \check@@footnoterule@@box\flushend@@tempbox@a\flushend@@lastskip@b\flushend@@varbox@a
124    \check@@baselineskip@@skip\flushend@@lastskip@a\flushend@@lastskip@b\flushend@@lastskip@c
125    \ifvoid\flushend@@tempbox@a
126        \ifdim\ht\flushend@@varbox@a>\topskip
127            \flushend@@lastskip@b\ht\flushend@@varbox@a
128            \var@@temp@a\ht\flushend@@varbox@a
129            \loop
130                \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
131                \ifvoid\flushend@@varbox@a
132                    \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
133                    \advance \var@@temp@a -3\p@
134                \else
135                    \var@@temp@a=-1\p@
136                \fi
137            \ifdim \var@@temp@a>\z@
138            \repeat
139            \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@varbox@a}%
140            \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
141            \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
142            \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
143            \wlog@balance@debug{..--box: \log@box@info{\flushend@@tempbox@c}%
144                   ^^J..--lastbox: \log@box@info{\flushend@@varbox@a}%
145                   ^^J..--diff: \the\flushend@@lastskip@b}%
146            \check@@footnoterule@@box\flushend@@varbox@a\flushend@@lastskip@b
147                \flushend@@tempbox@c
148            \check@@baselineskip@@skip\flushend@@lastskip@a\flushend@@lastskip@b
149                \flushend@@lastskip@c
150            \ifdim\ht\flushend@@varbox@a>.5\topskip
151                \analyze@lastbox@box\flushend@@varbox@a
152            \fi
153            \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
154        \else
155            \wlog@balance@debug{lastbox: \log@box@info{\flushend@@varbox@a}}%
156        \fi
157    \fi
158    \ifdim\ht\flushend@@varbox@a>\topskip
159        \expandafter\analyze@leftcolumn@box\expandafter\flushend@@varbox@a
160    \fi
```

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```
161    }
```

`\get@@footnoterule@@box`

```
162 \def\get@@footnoterule@@box{%
163     \splittopskip\z@ \vfuzz\maxdimen \vbadness\maxdimen
164     \setbox\flushend@@varbox@a\vbox{\strut
165         \vskip\z@
166         \footnoterule
167         \unskip\unkern\unpenalty
168         \unskip\unkern\unpenalty
169         }%
170     \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\ht\strutbox
171     \xdef\footnoterule@@box@@ht{\the\ht\flushend@@varbox@a}%
172     \xdef\footnoterule@@box@@dp{\the\dp\flushend@@varbox@a}%
173     \xdef\footnoterule@@box@@wd{\the\wd\flushend@@varbox@a}%
174     \wlog@balance@debug{:footnoterule: \log@box@info{\flushend@@varbox@a}}%
175     }
```

`\check@@footnoterule@@box` {⟨*box*⟩}{⟨*skip*⟩}{⟨*box*⟩}

```
176 \def\check@@footnoterule@@box#1#2#3{%
177     \ifdim\ht#1=\footnoterule@@box@@ht
178       \ifdim\dp#1=\footnoterule@@box@@dp
179         \ifdim\wd#1=\footnoterule@@box@@wd
180           \ifdim#2>\topskip
181             \xdef\main@box@height{\the\ht#3}%
182             \xdef\main@box@skip{\the#2}%
183           \fi
184         \fi
185       \fi
186     \fi
187   }
```

`\check@@baselineskip@@skip` {⟨*dimension*⟩}{⟨*dimension*⟩}{⟨*var*⟩}

```
188 \def\check@@baselineskip@@skip#1#2#3{%
189     \ifdim#1>\z@
190       \ifdim#2>\z@
191         \global#3=\the#1%
192         \gdef\check@@baselineskip@@skip##1##2##3{}%
193       \fi
194     \fi
195   }
```

`\analyze@rightcolumn@box` {⟨*box*⟩}

```
196 \def\analyze@rightcolumn@box#1{%
197   \bgroup
198     \xdef\top@@floatbox@ht{\z@}%
199     \xdef\top@@floatbox@skip{\z@}%
200     \xdef\top@@section@skip{\z@}%
201     \splittopskip\z@ \vfuzz\maxdimen \vbadness\maxdimen
```

```
202        \wlog@balance@debug{^^J(R)mainbox: \log@box@info{#1}}%
203        \var@@temp@a3\p@
204        \setbox\flushend@@varbox@a\vbox{\strut
205                  \vskip\z@
206                  \unvcopy#1%
207                }%
208        \splittopskip\z@
209        \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\ht\strutbox
210        \flushend@@lastskip@a\ht\flushend@@varbox@a
211        \advance\flushend@@lastskip@a\dp\flushend@@varbox@a
212        \loop
213            \flushend@@lastskip@b\ht\flushend@@varbox@a
214            \advance\flushend@@lastskip@b\dp\flushend@@varbox@a
215            \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
216            \ifvoid\flushend@@tempbox@c
217                \advance \var@@temp@a 3\p@
218                \ifdim\var@@temp@a>\flushend@@lastskip@b
219                    \var@@temp@a=-1\p@
220                \fi
221            \else
222                \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
223                \ifdim\ht\flushend@@tempbox@c>\top@@floatbox@min
224                    \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
225                    \advance\flushend@@lastskip@b -\dp\flushend@@tempbox@c
226                    \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
227                    \advance\flushend@@lastskip@b -\dp\flushend@@varbox@a
228                    \xdef\top@@floatbox@skip{\the\flushend@@lastskip@b}%
229                    \flushend@@lastskip@b\flushend@@lastskip@a
230                    \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
231                    \advance\flushend@@lastskip@b -\top@@floatbox@skip
232                    \xdef\top@@floatbox@ht{\the\flushend@@lastskip@b}%
233                    \var@@temp@a=3\p@
234                \else
235                    \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
236                    \advance\flushend@@lastskip@b -\dp\flushend@@tempbox@c
237                    \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
238                    \advance\flushend@@lastskip@b -\dp\flushend@@varbox@a
239                    \ifdim\ht\flushend@@tempbox@c>\topskip
240                    \else
241                        \xdef\top@@section@skip{\the\flushend@@lastskip@b}%
242                    \fi
243                    \var@@temp@a=-1\p@
244                \fi
245            \fi
246        \ifdim \var@@temp@a>\z@
247        \repeat
248        \ifvoid\flushend@@tempbox@c
249        \else
250            \ifdim\top@@section@skip>\z@
251            \else
```

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```
252                   \ifdim\ht\flushend@@tempbox@c>\z@
253                       \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
254                   \fi
255                   \flushend@@lastskip@b\ht\flushend@@varbox@a
256                   \var@@temp@a=3\p@
257                   \loop
258                       \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
259                       \ifvoid\flushend@@tempbox@c
260                           \advance \var@@temp@a 3\p@
261                           \ifdim\var@@temp@a>\flushend@@lastskip@b
262                               \var@@temp@a=-1\p@
263                           \fi
264                       \else
265                           \ifdim\ht\flushend@@tempbox@c>\z@
266                               \var@@temp@a=-1\p@
267                           \fi
268                       \fi
269                   \ifdim \var@@temp@a>\z@
270                   \repeat
271                   \loop
272                       \setbox\flushend@@varbox@a\vbox{%
273                           \unvbox\flushend@@tempbox@c
274                           \unskip\unkern\unpenalty
275                           \unskip\unkern\unpenalty
276                           \unskip\unkern\unpenalty
277                           \setbox\flushend@@tempbox@c\lastbox
278                         }%
279                       \flushend@@lastskip@b\ht\flushend@@varbox@a
280                       \setbox\flushend@@varbox@a\vbox{%
281                           \unvbox\flushend@@varbox@a
282                           \unskip\unkern\unpenalty
283                           \unskip\unkern\unpenalty
284                           \unskip\unkern\unpenalty
285                         }%
286                       \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
287                       \ifdim\flushend@@lastskip@b>\topskip
288                           \xdef\top@@section@skip{\the\flushend@@lastskip@b}%
289                       \fi
290                   \ifdim\ht\flushend@@varbox@a>2\topskip
291                       \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@varbox@a}%
292                   \repeat
293               \fi
294           \fi
295   \egroup
296   }
```

\last@outputdblcol Columns balancing of the twocolumn mode page (modern variant).

```
297 \def\last@outputdblcol@modern{%
298   \if@firstcolumn
299       \global \@firstcolumnfalse
```

```
300        \global \setbox\@leftcolumn \box\@outputbox
301    \else
302        \global \@firstcolumntrue
303        \@tempdima\ht\@leftcolumn
304        \splittopskip\topskip \splitmaxdepth\maxdepth
305        \var@@temp@spread=\wd\@outputbox
306        \get@@footnoterule@@box
307        \xdef\main@box@height{\the\ht\@leftcolumn}%
308        \xdef\main@box@skip{\z@}%
309        \global\flushend@@lastskip@c\z@
310        \setbox\flushend@@varbox@a\vbox{\unvcopy\@leftcolumn}%
311        \analyze@leftcolumn@box\flushend@@varbox@a
312        \setbox\flushend@@varbox@a\vbox{\unvcopy\@outputbox}%
313        \analyze@rightcolumn@box\flushend@@varbox@a
314        \if@auto@baselineskip
315            %% Trying guess baselineskip value on column break
316            \ifdim\main@box@skip>\z@
317                \splittopskip\z@
318                \setbox\flushend@@varbox@a\vsplit\@leftcolumn to\main@box@height
319            \else
320                \setbox\flushend@@varbox@a\box\@leftcolumn
321            \fi
322            \ifdim\var@@temp@spread>\z@
323                \setbox\@outputbox\vbox{\strut
324                    \vskip\z@
325                    \unvbox\@outputbox
326                  }%
327                \splittopskip\z@
328                \setbox\flushend@@tempbox@c\vsplit\@outputbox to\ht\strutbox
329                \ifdim\top@@floatbox@skip>\z@
330                    \setbox\flushend@@tempbox@c\vsplit\@outputbox to\top@@floatbox@ht
331                    \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
332                \fi
333                \setbox\@tempboxa\vbox{%
334                    \unvbox\flushend@@varbox@a
335                    \unskip\unkern\unpenalty
336                    \vskip\flushend@@lastskip@c
337                    \the\atColsBreak
338                    \hrule\@height\flushend@@page@rule width\columnwidth
339                    \ifdim\top@@section@skip>\top@@skip@@limit
340                        \vskip\top@@section@skip
341                    \fi
342                    \unvbox\@outputbox
343                    \remove@lastbox@at@balancing
344                    \the\atColsEnd
345                  }%
346                \ifdim\top@@floatbox@skip>\z@
347                    \setbox\@outputbox\vbox{\unvbox\flushend@@tempbox@c}%
348                \fi
349            \else %% rightcolumn empty
```

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```
350            \setbox\@tempboxa\vbox{%
351                \unvbox\flushend@@varbox@a
352                \remove@lastbox@at@balancing
353                \the\atColsEnd
354                }%
355        \fi
356    \else
357        %% Ignore baselineskip value on column break
358        \ifdim\var@@temp@spread>\z@
359            \setbox\@outputbox\vbox{\strut
360                \vskip\z@
361                \unvbox\@outputbox
362              }%
363            \splittopskip\z@
364            \setbox\flushend@@tempbox@c\vsplit\@outputbox to\ht\strutbox
365            \setbox\@tempboxa\vbox{%
366                \unvbox\@leftcolumn
367                \setbox\z@\lastbox
368                \unskip\unkern\unpenalty
369                \the\atColsBreak
370                \hrule\@height\flushend@@page@rule width\columnwidth
371                \unvbox\@outputbox
372                \remove@lastbox@at@balancing
373                \the\atColsEnd
374                }%
375        \else
376            \setbox\@tempboxa\vbox{%
377                \unvbox\@leftcolumn
378                \remove@lastbox@at@balancing
379                \the\atColsEnd
380                }%
381        \fi
382    \fi
383    \ifdim\main@box@skip>\z@
384        \@tempdimb\ht\@tempboxa
385        \advance\@tempdimb -\main@box@skip
386        \advance\@tempdimb -\ht\@leftcolumn
387        \@tempdimb .5\@tempdimb
388        \splittopskip\topskip \splitmaxdepth\maxdepth
389        \loop
390            \setbox\flushend@@varbox@a\copy\@tempboxa
391            \setbox\flushend@@tempbox@a\vsplit\flushend@@varbox@a to\@tempdimb
392            \setbox\flushend@@tempbox@c\vbox{%
393                \unvcopy\flushend@@tempbox@a
394                \vskip\main@box@skip
395                \unvcopy\@leftcolumn
396                }%
397            \setbox\flushend@@varbox@c\vbox{\unvbox\flushend@@varbox@a}%
398            \var@@temp@spread=\ht\flushend@@tempbox@c
399            \advance\var@@temp@spread by-\ht\flushend@@varbox@c
```

```
400        \wlog@balance@debug{Left x: \the\ht\flushend@@tempbox@a
401                            +\the\dp\flushend@@tempbox@a=\the\ht\flushend@@varbox@a
402                            +\the\dp\flushend@@varbox@a::\the\@tempdimb
403            ^^JLeft 0: \the\ht\flushend@@tempbox@c
404                            +\the\dp\flushend@@tempbox@c::\the\@tempdimb
405            ^^JRight x: \the\ht\flushend@@varbox@c
406                            +\the\dp\flushend@@varbox@c=\the\ht\flushend@@varbox@a
407                            +\the\dp\flushend@@varbox@a::\the\@tempdimb
408            ^^JExtra height:\the\var@@temp@spread\space when \the\@tempdimb
409                }%
410        \ifdim\var@@temp@spread<\z@ \advance\@tempdimb 1\p@ \repeat
411        \flushend@@lastskip@a\the\ht\flushend@@tempbox@c
412        \flushend@@lastskip@b\the\@tempdimb
413        \setbox\flushend@@tempbox@a\vsplit\@tempboxa to\@tempdimb
414        \setbox\@leftcolumn\vbox to\@tempdima{%
415            \vbox to \flushend@@lastskip@a{%
416                \unvbox\flushend@@tempbox@a
417                \vskip\main@box@skip
418                \unvbox\@leftcolumn
419                \vss
420              }%
421            \hrule\@height\flushend@@page@rule width\textwidth
422            \vss
423            }%
424        \global\ht\@leftcolumn=\the\@tempdima
425        \wlog{- LAST -%
426            ^^JExtra skip:\the\var@@temp@spread
427            ^^JLeft:\the\ht\@leftcolumn/\the\dp\@leftcolumn
428            ^^JRight:\the\ht\@tempboxa/\the\dp\@tempboxa
429            ^^JOutput:\the\@tempdimb
430            }%
431        \setbox\@outputbox\vbox to\@tempdima{%
432            \vbox spread\var@@temp@spread{%
433                \unvbox\@tempboxa
434                }%
435            \vss
436            }%
437   \else
438        \@tempdimb \ht\@tempboxa
439        \ifdim\top@@floatbox@skip>\z@
440            \advance\@tempdimb \top@@floatbox@skip
441            \advance\@tempdimb \top@@floatbox@ht
442        \fi
443        \@tempdimb .5\@tempdimb
444        \splittopskip\topskip \splitmaxdepth\maxdepth
445        \loop
446            \setbox\flushend@@varbox@a\copy\@tempboxa
447            \setbox\flushend@@tempbox@a\vsplit\flushend@@varbox@a to\@tempdimb
448            \setbox\flushend@@tempbox@c\vbox{\unvcopy\flushend@@tempbox@a}%
449            \ifdim\top@@floatbox@skip>\z@
```

11

```
450              \setbox\flushend@@varbox@c\vbox{%
451                  \unvcopy\@outputbox
452                  \vskip\top@@floatbox@skip
453                  \unvbox\flushend@@varbox@a
454                }%
455            \else
456                \setbox\flushend@@varbox@c\vbox{\unvbox\flushend@@varbox@a}%
457            \fi
458            \var@@temp@spread=\ht\flushend@@tempbox@c
459            \advance\var@@temp@spread by\dp\flushend@@tempbox@c
460            \advance\var@@temp@spread by-\ht\flushend@@varbox@c
461            \advance\var@@temp@spread by-\dp\flushend@@varbox@c
462            \wlog@balance@debug{Left x: \the\ht\flushend@@tempbox@a
463                        +\the\dp\flushend@@tempbox@a=\the\ht\flushend@@varbox@a
464                        +\the\dp\flushend@@varbox@a::\the\@tempdimb
465          ^^JLeft 0: \the\ht\flushend@@tempbox@c
466                        +\the\dp\flushend@@tempbox@c::\the\@tempdimb
467          ^^JRight x: \the\ht\flushend@@varbox@c
468                        +\the\dp\flushend@@varbox@c=\the\ht\flushend@@varbox@a
469                        +\the\dp\flushend@@varbox@a::\the\@tempdimb
470          ^^JExtra height:\the\var@@temp@spread\space when \the\@tempdimb
471                }%
472        \ifdim\var@@temp@spread<\z@ \advance\@tempdimb 1\p@ \repeat
473        %\@tempdimb\ht\flushend@@tempbox@c
474        %\advance\@tempdimb by\dp\flushend@@tempbox@c
475        \wlog{- LAST -%
476              ^^JExtra skip:\the\var@@temp@spread
477              ^^JLeft:\the\ht\flushend@@tempbox@c/\the\dp\flushend@@tempbox@c
478              ^^JRight:\the\ht\flushend@@varbox@c/\the\dp\flushend@@varbox@c
479              ^^JOutput:\the\@tempdimb
480            }%
481        \setbox\flushend@@tempbox@c\vsplit\@tempboxa to\@tempdimb
482        \setbox\flushend@@varbox@c\vbox{\unvbox\flushend@@tempbox@c}%
483        \setbox\@leftcolumn\vbox to\@tempdima{%
484            \vbox to\@tempdimb{\unvbox\flushend@@varbox@c\vss}%
485            \hrule\@height\flushend@@page@rule width\textwidth
486            \vss
487            }%
488        \global\ht\@leftcolumn=\the\@tempdima
489        \ifdim\top@@floatbox@skip>\z@
490            \setbox\@outputbox\vbox to\@tempdima{%
491                \if@right@column@spread
492                    \vbox spread\var@@temp@spread{%
493                        \unvbox\@outputbox
494                        \vskip\top@@floatbox@skip
495                        \unvbox\@tempboxa
496                        }%
497                \else
498                    \vbox spread\var@@temp@spread{%
499                        \unvbox\@outputbox
```

```
500                           \vskip\top@@floatbox@skip
501                           \unvbox\@tempboxa
502                           \vss
503                           }%
504                   \fi
505                   \vss
506                   }%
507           \else
508               \setbox\@outputbox\vbox to\@tempdima{%
509                   \if@right@column@spread
510                       \vbox spread\var@@temp@spread{%
511                           \unvbox\@tempboxa
512                           }%
513                   \else
514                       \vbox spread\var@@temp@spread{%
515                           \unvbox\@tempboxa
516                           \vss
517                           }%
518                   \fi
519                   \vss
520                   }%
521           \fi
522       \fi
523       \setbox\@outputbox \vbox {%
524           \hb@xt@\textwidth {%
525               \hb@xt@\columnwidth {%
526                   \fmt@box@adds{\box\@leftcolumn}\hss}%
527                   \hfil
528                   \vrule \@width\columnseprule
529                   \hfil
530                   \hb@xt@\columnwidth {%
531                       \fmt@box@adds{\box\@outputbox}\hss}%
532                       }%
533                   }%
534       \global\let\@outputdblcol\saved@orig@@outputdblcol
535       \global\atColsEnd{}%
536       \ifvoid\hold@viper
537       \else
538           \setbox\@outputbox\vbox{\box\hold@viper\box\@outputbox}%
539       \fi
540       \@combinedblfloats
541       \@outputpage
542       \begingroup
543           \@dblfloatplacement
544           \@startdblcolumn
545           \@whilesw\if@fcolmade\fi
546               {\@outputpage\@startdblcolumn}%
547           \ifvoid\@viper
548           \else
549               \global\setbox\@viper\vbox{%
```

13

```
550                         \vskip-\stripsep
551                         \unvbox\@viper
552                         }%
553                     \csname @viperoutput\endcsname
554                 \fi
555             \endgroup
556     \fi
557 }
```

\last@outputdblcol@old Columns balancing of the twocolumn mode page (ancient algorithm).

```
558 \def\last@outputdblcol@ancient{%
559     \if@firstcolumn
560         \global\@firstcolumnfalse
561         \global\setbox\@leftcolumn\box\@outputbox
562     \else
563         \global\@firstcolumntrue
564         \@tempdima\ht\@leftcolumn
565         \splittopskip\topskip\splitmaxdepth\maxdepth
566         \if@auto@baselineskip
567             \setbox\@tempboxa\vbox{%
568                 \unvcopy\@leftcolumn
569     \global\flushend@@lastskip@c\lastskip
570     \global\flushend@@lastskip@b\lastskip
571                 \loop
572         \global\flushend@@lastskip@a\flushend@@lastskip@b
573         \unskip\unpenalty
574         \global\flushend@@lastskip@b\lastskip
575         \global\advance\flushend@@lastskip@c by\lastskip
576     \ifdim\flushend@@lastskip@b=-\flushend@@lastskip@a
577         \global\advance\flushend@@lastskip@c by-\lastskip
578                 \else
579                 \repeat
580     \ifdim\flushend@@lastskip@b=-\flushend@@lastskip@a
581         \ifdim\flushend@@lastskip@b=\z@
582             \setbox\flushend@@varbox@a\lastbox
583             \global\advance\flushend@@lastskip@c by\ht\flushend@@varbox@a
584             \global\advance\flushend@@lastskip@c by\lastskip
585             \unskip\unpenalty
586             \setbox\flushend@@varbox@a\lastbox
587             \global\advance\flushend@@lastskip@c by\dp\flushend@@varbox@a
588         \else
589             \global\flushend@@lastskip@c\lastskip
590             \global\advance\flushend@@lastskip@c by\topskip
591         \fi
592             \fi
593             \global\advance\flushend@@lastskip@c by-\topskip
594         }%
595         \setbox\@tempboxa\vbox{%
596             \unvbox\@leftcolumn
597             \unskip\unpenalty
```

14

```
598                    \vskip\flushend@@lastskip@c
599                    \hrule\@height\flushend@@page@rule width\columnwidth
600                    \the\atColsBreak
601            \unvbox\@outputbox
602                    \remove@lastbox@at@balancing
603                    %%\unskip
604                    \the\atColsEnd
605            }%
606            \else
607                \setbox\@tempboxa\vbox{%
608                    \unvbox\@leftcolumn
609                    \setbox\z@\lastbox
610                    \unskip
611                    \hrule\@height\flushend@@page@rule width\columnwidth
612                    \the\atColsBreak
613                    \unvbox\@outputbox
614                    \remove@lastbox@at@balancing
615                    %%\setbox\z@\lastbox
616                    %%\unskip
617                    \the\atColsEnd
618                    }%
619            \fi
620            \@tempdimb .5\ht\@tempboxa
621            \loop
622                \setbox\flushend@@tempbox@a\copy\@tempboxa
623                \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
624                    \vsplit\flushend@@tempbox@a to\@tempdimb
625                    \vss
626                    \vsplit\flushend@@tempbox@a to\@tempdimb
627                    }%
628                \wlog{Extra height:\the\ht\flushend@@tempbox@a\space when \the\@tempdimb}%
629            \ifvoid\flushend@@tempbox@a \else \advance\@tempdimb 1\p@ \repeat
630            \loop
631                \setbox\flushend@@tempbox@a\copy\@tempboxa
632                \setbox\flushend@@tempbox@c\vbox to\@tempdimb{\vsplit\flushend@@tempbox@a to\@te
633                \wlog{(2)Left:\the\ht\flushend@@tempbox@c\space
634                    Right:\the\ht\flushend@@tempbox@a\space
635                    Output:\the\@tempdimb
636                    }%
637            \ifdim\ht\flushend@@tempbox@c<\ht\flushend@@tempbox@a \@tempdimb=\the\ht\flushend@@t
638            \wlog{- LAST -^^JExtra skip: \the\z@
639                        ^^JLeft:\the\ht\flushend@@tempbox@c
640                        ^^JRight:\the\ht\flushend@@tempbox@a
641                        ^^JOutput:\the\@tempdimb
642                }%
643            \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
644                \vsplit\@tempboxa to\@tempdimb
645                \vss
646                }%
647            \setbox\@leftcolumn\vbox to\@tempdima{%
```

15

```
648            \fmt@vbox@adds[\columnwidth]{\vbox to\@tempdimb{\unvbox\flushend@@tempbox@c}}%
649            \hrule\@height\flushend@@page@rule
650            \vss
651            }%
652        \setbox\@outputbox\vbox to\@tempdima{%
653            \fmt@vbox@adds[\columnwidth]{%
654                \vbox to\@tempdimb{%
655                    \unvbox\@tempboxa
656                    %\vfilneg
657                    \vskip\z@
658                    }%
659                }%
660            \hrule\@height\flushend@@page@rule
661            \vss
662            }%
663        \setbox\@outputbox\vbox{%
664            \hb@xt@\textwidth{%
665                \hb@xt@\columnwidth{\box\@leftcolumn\hss}%
666                \hfil
667                \vrule \@width\columnseprule
668                \hfil
669                \hb@xt@\columnwidth{\box\@outputbox\hss}%
670                }%
671            }%
672        \global\let\@outputdblcol\saved@orig@@outputdblcol
673        \global\atColsEnd{}%
674        \ifvoid\hold@viper
675        \else
676            \setbox\@outputbox\vbox{\box\hold@viper\box\@outputbox}%
677        \fi
678        \@combinedblfloats
679        \@outputpage
680        \begingroup
681            \@dblfloatplacement
682            \@startdblcolumn
683            \@whilesw\if@fcolmade\fi
684                {\@outputpage\@startdblcolumn}%
685            \ifvoid\@viper
686            \else
687                \global\setbox\@viper\vbox{%
688                    \vskip-\stripsep
689                    \unvbox\@viper
690                    }%
691                \csname @viperoutput\endcsname
692            \fi
693        \endgroup
694    \fi
695    }
```

Adds default balancing of the last page at the end of document.

```
696 \usepackage{etoolbox}
697 \AtBeginDocument{%
698     \global\let\saved@orig@@outputdblcol\@outputdblcol
699     \if@ancient@balance@version
700         \global\let\last@outputdblcol\last@outputdblcol@ancient
701     \else
702         \global\let\last@outputdblcol\last@outputdblcol@modern
703     \fi
704     \global\let\balanced@@outputdblcol\last@outputdblcol
705     \preto\enddocument{\let\@outputdblcol\balanced@@outputdblcol}%
706     \appto\footnoterule{\vskip\z@}%
707     }
```

User interface commands for the balancing pages.

```
708 \def\flushcolsend{\global\let\@outputdblcol\last@outputdblcol}
709 \def\raggedcolsend{\global\let\@outputdblcol\saved@orig@@outputdblcol}
710 \def\flushend{\global\let\balanced@@outputdblcol\last@outputdblcol}
711 \def\raggedend{\global\let\balanced@@outputdblcol\saved@orig@@outputdblcol}
```

```
712 \if@balance@debug
713     \showcolsendrule
714 \fi
```