# The **flushend** package

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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@debugfalse
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   \if@remove@lastbox@at@balancing
46   \else
47     \expandafter\null
48   \fi
49   \bgroup
50     \setbox\z@\lastbox
51     \ifdim\wd\z@>\z@
52       \box\z@
53     \else
54       \aftergroup\unskip@three@kern@penalty
55     \fi
56   \egroup
57   }
```

   Macros used in debug mode.

```
58 \def\show@@box#1{%
59   \bgroup
60     \showboxbreadth=20000\showboxdepth=20000%
61     \showbox#1\relax
62   \egroup
63   }
64 \def\wlog@balance@debug#1{\if@balance@debug \wlog{#1}\fi}
65 \def\log@box@info#1{<box\the#1>(\the\ht#1+\the\dp#1)x\the\wd#1}
66 \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.

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

\analyze@leftcolumn@box  $\{\langle box \rangle\}$

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

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

`\get@@footnoterule@@box`

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

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

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

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

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

`\analyze@rightcolumn@box`  `{⟨box⟩}`

```
194 \def\analyze@rightcolumn@box#1{%
195   \bgroup
196     \xdef\top@@floatbox@ht{\z@}%
197     \xdef\top@@floatbox@skip{\z@}%
198     \xdef\top@@section@skip{\z@}%
199     \splittopskip\z@ \vfuzz\maxdimen \vbadness\maxdimen
200     \wlog@balance@debug{^^J(R)mainbox: \log@box@info{#1}}%
201     \var@@temp@a3\p@
```

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

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

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

```
295 \def\last@outputdblcol@modern{%
296    \if@firstcolumn
297        \global \@firstcolumnfalse
298        \global \setbox\@leftcolumn \box\@outputbox
299    \else
```

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

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

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

11

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

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

```
550                    }%
551                    \csname @viperoutput\endcsname
552                \fi
553          \endgroup
554   \fi
555   }
```

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

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

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

15

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

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

```
694 \usepackage{etoolbox}
695 \AtBeginDocument{%
```

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

User interface commands for the balancing pages.

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

```
710 \if@balance@debug
711     \showcolsendrule
712 \fi
```