The **flushend** package

Sigitas Tolušis
sigitas@vtex.lt

v3.5 from 2020/10/16

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. This version is not so accurate or "clever" but quite safe.

modern   [default] It is used to switch on new version of balancing algorithm. This version has some heuristic guesses for footnotes, floats and section like head skip. So it is more dangerous in the case for text misplace or disappear.

autobase   [default] 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   [default] It adds extra glue to the rightcolumn trying to balance.

nospread   It skips adding extra glue to the last column.

removelastbox   [default] It tries to remove an empty box (some more material) from the last column bottom.

keeplastbox   It skips removing anything from the last column. As example it is usefull and can be used then document ends by reference item and last line of text should be with indend.

checkfootnote   [default] Adds guess for footnote on left column then modern balancing algorithm is in use.

nocheckfootnote   Skips guess for footnote then modern balansing algorithm is in use.

checkfloat   [default] Adds guess for top float on right column then modern balancing algorithm is in use.

nocheckfloat   Skips guess for top float on right column then modern balancing algorithm is in use.

debug   Adds rules to the bottom of columns (just for debugging) and leftcolumn break place. Adds some additional log info.

nodebug   [default] Skips putting debuging lines.

3 Implementation

```
/*
1 */
2 %    \begin{macrocode}
3 \newif\if@auto@baselineskip \@auto@baselineskiptrue
4 \newif\if@ancient@balance@version \@ancient@balance@versionfalse
5 \newif\if@right@column@spread \@right@column@spreadtrue
6 \newif\if@remove@lastbox@at@balancing \@remove@lastbox@at@balancingtrue
7 \newif\if@balance@debug \@balance@debugfalse
8 \DeclareOption{autobase}{\global\@auto@baselineskiptrue}
```

```
 9 \DeclareOption{noautobase}{\global\@auto@baselineskipfalse}
10 \DeclareOption{ancient}{\global\@ancient@balance@versiontrue}
11 \DeclareOption{modern}{\global\@ancient@balance@versionfalse}
12 \DeclareOption{spread}{\global\@right@column@spreadtrue}
13 \DeclareOption{nospread}{\global\@right@column@spreadfalse}
14 \DeclareOption{removelastbox}{\global\@remove@lastbox@at@balancingtrue}
15 \DeclareOption{keeplastbox}{\global\@remove@lastbox@at@balancingfalse}
16 \DeclareOption{checkfootnote}{%
17     \AtEndOfPackage{%
18         \let\check@@footnoterule@@box\initial@check@@footnoterule@@box
19         }%
20     }
21 \DeclareOption{nocheckfootnote}{%
22     \AtEndOfPackage{%
23         \let\check@@footnoterule@@box\@gobblethree
24         }%
25     }
26 \DeclareOption{checkfloat}{%
27     \AtEndOfPackage{%
28         \let\top@@floatbox@min\top@@floatbox@min@default
29         }%
30     }
31 \DeclareOption{nocheckfloat}{%
32     \AtEndOfPackage{%
33         \let\top@@floatbox@min\maxdimen
34         }%
35     }
36 \DeclareOption{debug}{\global\@balance@debugtrue}
37 \DeclareOption{nodebug}{\global\@balance@debugfalse}
38 \ProcessOptions

39 \newskip\flushend@@lastskip@a
40 \newskip\flushend@@lastskip@b
41 \newskip\flushend@@lastskip@c
42 \newcount\flushend@@penalty@a
43 \newcount\var@@loop@iter
44 \newdimen\flushend@@lastkern@a
45 \newdimen\var@@temp@spread
46 \newdimen\var@@temp@a
47 \newdimen\var@@temp@loop
48 \def\top@@skip@@limit{.7\topskip}
49 \newdimen\flushend@@page@rule \flushend@@page@rule\z@
50 \def\showcolsendrule{\global\flushend@@page@rule=.4\p@}
```

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

```
51 \gdef\top@@floatbox@min@default{4\topskip}
52 \let\top@@floatbox@min\top@@floatbox@min@default

53 \newbox\flushend@@varbox@a
54 \newbox\flushend@@varbox@c
55 \newbox\flushend@@tempbox@a
```

```
56 \newbox\flushend@@tempbox@c
57 \@ifundefined{@viper}{\newbox\@viper}{}
58 \@ifundefined{hold@viper}{\newbox\hold@viper}{}

59 \newtoks\atColsBreak \atColsBreak={}
60 \newtoks\atColsEnd   \atColsEnd={}

61 \@ifundefined{fmt@box@adds}{\def\fmt@box@adds#1{#1}}{}
62 \@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.

```
63 \def\unskip@three@kern@penalty{%
64     \unskip\unkern\unpenalty
65     \unskip\unkern\unpenalty
66     \unskip\unkern\unpenalty
67     }
68 \gdef\remove@lastbox@at@balancing{%
69     \unskip@three@kern@penalty
70     \if@remove@lastbox@at@balancing
71     \else
72         \expandafter\null
73     \fi
74     \bgroup
75         \setbox\z@\lastbox
76         \ifdim\wd\z@>\z@
77             \box\z@
78         \else
79             \aftergroup\unskip@three@kern@penalty
80         \fi
81     \egroup
82     }
83 \def\set@split@topskip@to#1{%
84     \splittopskip#1\relax \vfuzz\maxdimen \vbadness\maxdimen
85     }
```

Macros used in debug mode.

```
86 \def\show@@box#1{%
87     \bgroup
88         \showboxbreadth=20000\showboxdepth=20000%
89         \showbox#1\relax
90     \egroup
91     }
92 \def\wlog@balance@debug#1{\if@balance@debug \wlog{#1}\fi}
93 \def\log@box@info#1{<box\the#1>(\the\ht#1+\the\dp#1)x\the\wd#1}
94 \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.

```
95 \gdef\analyze@lastbox@box#1{%
```

```
96      \setbox\flushend@@varbox@a\vbox{%
97          \unvbox#1%
98          \global\flushend@@lastskip@a\lastskip
99          \unskip
100         \global\var@@temp@a\lastkern
101         \unkern
102         \global\flushend@@penalty@a\lastpenalty
103         \unpenalty
104         \ifdim\lastskip>\z@
105             \global\flushend@@lastskip@a\lastskip
106         \fi
107         \unskip
108         \ifdim\lastkern>\z@
109             \global\var@@temp@a\lastkern
110         \fi
111         \unkern
112         \ifnum\lastpenalty>\z@
113             \global\flushend@@penalty@a\lastpenalty
114         \fi
115         \unpenalty
116         \global\setbox\flushend@@tempbox@a\lastbox
117         }%
118     \wlog@balance@debug{^^J::analyze@lastbox@box::\log@box@info{#1}%
119                         ^^J ::unvbox: \log@box@info{\flushend@@varbox@a}%
120                         ^^J::lastbox: \log@box@info{\flushend@@tempbox@a}%
121                         ^^J::lastskip: \the\flushend@@lastskip@a;
122                             lastkern: \the\var@@temp@a;
123                           lastpenalty: \the\flushend@@penalty@a
124                         }%
125     }
```

\analyze@leftcolumn@box   {⟨*box*⟩}

Fills:

- baselineskip skip from the last boxes to \flushend@@lastskip@c

- leftcolumn height without the footnote to \main@box@height

- footnote skip to \main@box@skip

```
126 \gdef\analyze@leftcolumn@box#1{%
127     \set@split@topskip@to\z@
128     \flushend@@lastskip@b\ht#1%
129     \wlog@balance@debug{^^Jmainbox: \log@box@info{#1}}%
130     \setbox\flushend@@varbox@a\vbox{%
131         \unvbox#1%
132         \global\flushend@@lastskip@a\lastskip
133         \unskip
134         \global\flushend@@lastkern@a\lastkern
135         \unkern
136         \global\flushend@@penalty@a\lastpenalty
```

```
137            \unpenalty
138            \global\setbox\flushend@@tempbox@a\lastbox
139            }%
140        \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
141        \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@a
142        \wlog@balance@debug{.-box: \log@box@info{\flushend@@varbox@a}%
143                    ^^J.-lastbox: \log@box@info{\flushend@@tempbox@a}%
144                   ^^J.-lastskip: \the\flushend@@lastskip@a;
145                      lastkern: \the\flushend@@lastkern@a;
146                   lastpenalty: \the\flushend@@penalty@a
147                     ^^J.-diff: \the\flushend@@lastskip@b
148            }%
149        \check@@footnoterule@@box\flushend@@tempbox@a\flushend@@lastskip@b\flushend@@varbox@a
150        \check@@baselineskip@@skip
151            \flushend@@lastskip@a
152            \flushend@@lastskip@b
153            \flushend@@lastskip@c
154        \ifx\check@@footnoterule@@box\check@@baselineskip@@skip
155        \else
156            \ifvoid\flushend@@tempbox@a
157                \ifdim\ht\flushend@@varbox@a>\topskip
158                    \flushend@@lastskip@b\ht\flushend@@varbox@a
159                    \var@@temp@a\ht\flushend@@varbox@a
160                    \loop
161                        \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
162                        \ifvoid\flushend@@varbox@a
163                            \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
164                            \advance \var@@temp@a -3\p@
165                        \else
166                            \var@@temp@a=-1\p@
167                        \fi
168                    \ifdim \var@@temp@a>\z@
169                    \repeat
170                    \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@varbox@a}%
171                    \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
172                    \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
173                    \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
174                    \wlog@balance@debug{..--box: \log@box@info{\flushend@@tempbox@c}%
175                            ^^J..--lastbox: \log@box@info{\flushend@@varbox@a}%
176                               ^^J..--diff: \the\flushend@@lastskip@b
177                        }%
178                    \check@@footnoterule@@box\flushend@@varbox@a\flushend@@lastskip@b
179                        \flushend@@tempbox@c
180                    \check@@baselineskip@@skip\flushend@@lastskip@a\flushend@@lastskip@b
181                        \flushend@@lastskip@c
182                    \ifx\check@@footnoterule@@box\check@@baselineskip@@skip
183                    \else
184                        \ifdim\ht\flushend@@varbox@a>.5\topskip
185                            \analyze@lastbox@box\flushend@@varbox@a
186                        \fi
```

6

```
187              \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
188            \fi
189          \else
190              \wlog@balance@debug{lastbox: \log@box@info{\flushend@@varbox@a}}%
191          \fi
192        \fi
193        \ifdim\var@@temp@loop=\ht\flushend@@varbox@a\relax
194            \global\advance\var@@loop@iter\@ne
195        \fi
196        \var@@temp@loop=\ht\flushend@@varbox@a\relax
197        \ifnum\var@@loop@iter<3\relax
198            \wlog@balance@debug{analyze left col: iteration \number\var@@loop@iter; ht \the\
199        \else
200            \wlog@balance@debug{analyze left col loop limit!}%
201            \ht\flushend@@varbox@a\z@
202        \fi
203        \ifdim\ht\flushend@@varbox@a>\topskip
204            \expandafter\analyze@leftcolumn@box\expandafter\flushend@@varbox@a
205        \fi
206    \fi
207    }
```

\get@@footnoterule@@box Gets dimensions of the box made by footnoterule and writes to: \footnoterule@@box@@ht, \footnoterule@@box@@dp, \footnoterule@@box@@wd.

```
208 \def\get@@footnoterule@@box{%
209     \set@split@topskip@to\z@
210     \setbox\flushend@@varbox@a\vbox{\strut
211         \vskip\z@
212         \footnoterule
213         \unskip\unkern\unpenalty
214         \unskip\unkern\unpenalty
215         }%
216     \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\p@
217     \xdef\footnoterule@@box@@ht{\the\ht\flushend@@varbox@a}%
218     \xdef\footnoterule@@box@@dp{\the\dp\flushend@@varbox@a}%
219     \xdef\footnoterule@@box@@wd{\the\wd\flushend@@varbox@a}%
220     \wlog@balance@debug{:footnoterule: \log@box@info{\flushend@@varbox@a}}%
221     \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@varbox@a}%
222     }
```

\check@@footnoterule@@box {⟨box1⟩}{⟨skip⟩}{⟨box2⟩}

Checks if {⟨box1⟩} dimensions equals to footnoterule box dimensions. If so and if {⟨skip⟩} is not \topskip we guess it is footnote. In that case we define leftcolumn height without footnote as {⟨box2⟩} height and save it as \main@box@height. Skip from text to footnote define as \main@box@skip.

```
223 \long\def\@gobblethree#1#2#3{}
224 \def\check@@footnoterule@@box#1#2#3{%
225     \ifdim\ht#1=\footnoterule@@box@@ht
226         \ifdim\dp#1=\footnoterule@@box@@dp
```

7

```
227            \ifdim\wd#1=\footnoterule@@box@@wd
228                \ifdim#2=\topskip
229                \else
230                    \xdef\main@box@height{\the\ht#3}%
231                    \xdef\main@box@skip{\the#2}%
232                    \wlog@balance@debug{^^J:footnoterule found:
233                                        main@box <ht=\main@box@height,
234                                        skip=\main@box@skip>
235                                        }%
236                    \global\let\check@@footnoterule@@box\@gobblethree
237                    \global\let\check@@baselineskip@@skip\reset@check@@baselineskip@@skip
238                \fi
239            \fi
240        \fi
241    \fi
242    }
243 \let\initial@check@@footnoterule@@box\check@@footnoterule@@box
```

\check@@baselineskip@@skip   {⟨*dimension1*⟩}{⟨*dimension2*⟩}{⟨*var*⟩}

    If both dimensions: {⟨*dimension1*⟩} and {⟨*dimension2*⟩} are positive we define by {⟨*var*⟩} value of {⟨*dimension1*⟩} as last skip between text lines and deactivate \check@@baselineskip@@skip itself.

```
244 \def\check@@baselineskip@@skip#1#2#3{%
245    \ifdim#1>\z@
246        \ifdim#2>\z@
247            \global#3=\the#1%
248            \global\let\check@@baselineskip@@skip\@gobblethree
249        \fi
250    \fi
251    }
252 \let\initial@check@@baselineskip@@skip\check@@baselineskip@@skip
```

    In the case we found footnote it is necessary to look for the last skip between text lines again. For that we use \reset@check@@baselineskip@@skip. It activates \check@@baselineskip@@skip.

```
253 \def\reset@check@@baselineskip@@skip#1#2#3{%
254    \global#3=\z@
255    \global\let\check@@baselineskip@@skip\initial@check@@baselineskip@@skip
256    }
```

\analyze@rightcolumn@box   {⟨*box*⟩}

    Some guess of possible float or section title at the top of right column. Fills:

- float height to \top@@floatbox@ht

- float skip to \top@@floatbox@skip

- head skip to \top@@section@skip

```
257 \def\analyze@rightcolumn@box#1{%
258     \bgroup
259         \xdef\top@@floatbox@ht{\z@}%
260         \xdef\top@@floatbox@skip{\z@}%
261         \xdef\top@@section@skip{\z@}%
262         \set@split@topskip@to\z@
263         \setbox\flushend@@varbox@a\vbox{\strut
264             \vskip\z@
265             \unvcopy#1%
266             }%
267         \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\p@
268         \wlog@balance@debug{^^J(R)mainbox: \log@box@info{#1}}%
269         \flushend@@lastskip@a\ht\flushend@@varbox@a
270         \advance\flushend@@lastskip@a\dp\flushend@@varbox@a
271         \ifdim\flushend@@lastskip@a>\z@
272             \analyze@nonempty@rightcolumn@box
273         \fi
274     \egroup
275     }
276 \def\analyze@nonempty@rightcolumn@box{%
277     \bgroup
278         \var@@temp@a3\p@
279         \loop
280             \flushend@@lastskip@b\ht\flushend@@varbox@a
281             \advance\flushend@@lastskip@b\dp\flushend@@varbox@a
282             \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
283             \ifvoid\flushend@@tempbox@c
284                 \advance \var@@temp@a 3\p@
285                 \ifdim\var@@temp@a>\flushend@@lastskip@b
286                     \var@@temp@a=-1\p@
287                 \fi
288             \else
289                 \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
290                 \ifdim\ht\flushend@@tempbox@c>\top@@floatbox@min
291                     \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
292                     \advance\flushend@@lastskip@b -\dp\flushend@@tempbox@c
293                     \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
294                     \advance\flushend@@lastskip@b -\dp\flushend@@varbox@a
295                     \xdef\top@@floatbox@skip{\the\flushend@@lastskip@b}%
296                     \flushend@@lastskip@b\flushend@@lastskip@a
297                     \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
298                     \advance\flushend@@lastskip@b -\top@@floatbox@skip
299                     \xdef\top@@floatbox@ht{\the\flushend@@lastskip@b}%
300                     \var@@temp@a=3\p@
301                 \else
302                     \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
303                     \advance\flushend@@lastskip@b -\dp\flushend@@tempbox@c
304                     \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
305                     \advance\flushend@@lastskip@b -\dp\flushend@@varbox@a
306                     \ifdim\ht\flushend@@tempbox@c>\topskip
```

```
307              \else
308                  \xdef\top@@section@skip{\the\flushend@@lastskip@b}%
309              \fi
310              \var@@temp@a=-1\p@
311          \fi
312      \fi
313  \ifdim \var@@temp@a>\z@
314  \repeat
315  \ifvoid\flushend@@tempbox@c
316  \else
317      \ifdim\top@@section@skip>\z@
318      \else
319          \ifdim\ht\flushend@@tempbox@c>\z@
320              \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
321          \fi
322          \flushend@@lastskip@b\ht\flushend@@varbox@a
323          \var@@temp@a=3\p@
324          \loop
325              \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
326              \ifvoid\flushend@@tempbox@c
327                  \advance \var@@temp@a 3\p@
328                  \ifdim\var@@temp@a>\flushend@@lastskip@b
329                      \var@@temp@a=-1\p@
330                  \fi
331              \else
332                  \ifdim\ht\flushend@@tempbox@c<\z@
333                  \else
334                      \var@@temp@a=-1\p@
335                  \fi
336              \fi
337          \ifdim \var@@temp@a>\z@
338          \repeat
339          \loop
340              \setbox\flushend@@varbox@a\vbox{%
341                  \unvbox\flushend@@tempbox@c
342                  \unskip\unkern\unpenalty
343                  \unskip\unkern\unpenalty
344                  \unskip\unkern\unpenalty
345                  \setbox\flushend@@tempbox@c\lastbox
346                  }%
347              \flushend@@lastskip@b\ht\flushend@@varbox@a
348              \setbox\flushend@@varbox@a\vbox{%
349                  \unvbox\flushend@@varbox@a
350                  \unskip\unkern\unpenalty
351                  \unskip\unkern\unpenalty
352                  \unskip\unkern\unpenalty
353                  }%
354              \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
355              \ifdim\flushend@@lastskip@b>\topskip
356                  \xdef\top@@section@skip{\the\flushend@@lastskip@b}%
```

```
357                         \fi
358                         \ifdim\var@@temp@loop=\ht\flushend@@varbox@a\relax
359                             \advance\var@@loop@iter\@ne
360                         \fi
361                         \var@@temp@loop=\ht\flushend@@varbox@a\relax
362                         \ifnum\var@@loop@iter<3\relax
363                             \wlog@balance@debug{analyze right col: iteration \number\var@@loop@i
364                         \else
365                             \wlog@balance@debug{analyze right col loop limit!}%
366                             \ht\flushend@@varbox@a=\z@
367                         \fi
368                     \ifdim\ht\flushend@@varbox@a>2\topskip
369                         \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@varbox@a}%
370                     \repeat
371                 \fi
372         \fi
373     \egroup
374     }
```

\combine@columns@for@balance   Collects both columns to one box removing left column footnotes and right column
                               top float and adding right skip in between them.

```
375 \def\combine@columns@for@balance{%
376     \setbox\@outputbox\vbox{\strut
377         \vskip\z@
378         \unvbox\@outputbox
379         }%
380     \set@split@topskip@to\z@
381     \setbox\flushend@@tempbox@c\vsplit\@outputbox to\p@
382     \if@auto@baselineskip
383         %% Trying guess baselineskip value on column break
384         \ifdim\top@@floatbox@skip>\z@
385             \setbox\flushend@@tempbox@c\vsplit\@outputbox to\top@@floatbox@ht
386             \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
387         \fi
388         \setbox\@tempboxa\vbox{%
389             \unvbox\flushend@@varbox@a
390             \unskip\unkern\unpenalty
391             \hrule\@height\flushend@@page@rule width\columnwidth
392             \vskip-\flushend@@page@rule
393             \hrule\@height\z@ width\columnwidth
394             \vskip\flushend@@lastskip@c
395             \the\atColsBreak
396             \ifdim\top@@section@skip>\top@@skip@@limit
397                 \vskip\top@@section@skip
398             \fi
399             \unvbox\@outputbox
400             \remove@lastbox@at@balancing
401             \the\atColsEnd
402             }%
403         \ifdim\top@@floatbox@skip>\z@
```

11

```
404            \setbox\@outputbox\vbox{\unvbox\flushend@@tempbox@c}%
405        \fi
406    \else
407        %% Ignore baselineskip value on column break
408        \setbox\@tempboxa\vbox{%
409            \unvbox\flushend@@varbox@a
410            \unskip\unkern\unpenalty
411            \hrule\@height\flushend@@page@rule width\columnwidth
412            \vskip-\flushend@@page@rule
413            \hrule\@height\z@ width\columnwidth
414            \the\atColsBreak
415            \unvbox\@outputbox
416            \remove@lastbox@at@balancing
417            \the\atColsEnd
418            }%
419    \fi
420    }
```

\set@outputbox@with@footnote   Calculates break position and formats balanced columns in the `\@outputbox` with footnotes.

```
421 \def\set@outputbox@with@footnote{%
422     %% footnote in left column
423     \@tempdimb\ht\@tempboxa
424     \ifdim\top@@floatbox@skip>\z@
425         \advance\@tempdimb \top@@floatbox@skip
426         \advance\@tempdimb \top@@floatbox@ht
427     \fi
428     \advance\@tempdimb \main@box@skip
429     \advance\@tempdimb \ht\@leftcolumn
430     \@tempdimb .5\@tempdimb
431     \advance\@tempdimb -\main@box@skip
432     \advance\@tempdimb -\ht\@leftcolumn
433     \set@split@topskip@to\topskip
434     \loop
435         \setbox\flushend@@varbox@a\copy\@tempboxa
436         \setbox\flushend@@tempbox@a\vsplit\flushend@@varbox@a to\@tempdimb
437         \setbox\flushend@@tempbox@c\vbox{\unvcopy\flushend@@tempbox@a}%
438         \ifdim\top@@floatbox@skip>\z@
439         \setbox\flushend@@varbox@c\vbox{%
440                 \unvcopy\@outputbox
441                 \vskip\top@@floatbox@skip
442                 \unvbox\flushend@@varbox@a
443                 }%
444         \else
445             \setbox\flushend@@varbox@c\vbox{\unvbox\flushend@@varbox@a}%
446         \fi
447         \var@@temp@spread=\ht\flushend@@tempbox@c
448         \advance\var@@temp@spread by\dp\flushend@@tempbox@c
449         \advance\var@@temp@spread \main@box@skip
450         \advance\var@@temp@spread \ht\@leftcolumn
```

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

13

```
501                            \vskip\top@@floatbox@skip
502                            \unvbox\@tempboxa
503                            \vss
504                            }%
505                    \fi
506                    \vss
507                    }%
508            \else
509                \setbox\@outputbox\vbox to\@tempdima{%
510                    \if@right@column@spread
511                        \vbox spread\var@@temp@spread{%
512                            \unvbox\@tempboxa
513                            }%
514                    \else
515                        \vbox spread\var@@temp@spread{%
516                            \unvbox\@tempboxa
517                            \vss
518                            }%
519                    \fi
520                    \vss
521                    }%
522            \fi
523            }
```

\set@outputbox@without@footnote   Calculates break position and formats balanced columns in the \@outputbox without footnotes.

```
524 \def\set@outputbox@without@footnote{%
525     %% no footnote in left column
526     \@tempdimb \ht\@tempboxa
527     \ifdim\top@@floatbox@skip>\z@
528         \advance\@tempdimb \top@@floatbox@skip
529         \advance\@tempdimb \top@@floatbox@ht
530     \fi
531     \@tempdimb .5\@tempdimb
532     \set@split@topskip@to\topskip
533     \loop
534         \setbox\flushend@@varbox@a\copy\@tempboxa
535         \setbox\flushend@@tempbox@a\vsplit\flushend@@varbox@a to\@tempdimb
536         \setbox\flushend@@tempbox@c\vbox{\unvcopy\flushend@@tempbox@a}%
537         \ifdim\top@@floatbox@skip>\z@
538             \setbox\flushend@@varbox@c\vbox{%
539                 \unvcopy\@outputbox
540                 \vskip\top@@floatbox@skip
541                 \unvbox\flushend@@varbox@a
542                 }%
543         \else
544             \setbox\flushend@@varbox@c\vbox{\unvbox\flushend@@varbox@a}%
545         \fi
546         \var@@temp@spread=\ht\flushend@@tempbox@c
547         \advance\var@@temp@spread by\dp\flushend@@tempbox@c
```

```
548         \advance\var@@temp@spread by-\ht\flushend@@varbox@c
549         \advance\var@@temp@spread by-\dp\flushend@@varbox@c
550         \wlog@balance@debug{Left x: \the\ht\flushend@@tempbox@a
551                         +\the\dp\flushend@@tempbox@a=\the\ht\flushend@@varbox@a
552                         +\the\dp\flushend@@varbox@a::\the\@tempdimb
553                         ^^JLeft 0: \the\ht\flushend@@tempbox@c
554                         +\the\dp\flushend@@tempbox@c::\the\@tempdimb
555                         ^^JRight x: \the\ht\flushend@@varbox@c
556                         +\the\dp\flushend@@varbox@c=\the\ht\flushend@@varbox@a
557                         +\the\dp\flushend@@varbox@a::\the\@tempdimb
558                         ^^JExtra height:\the\var@@temp@spread\space when \the\@tempdimb
559                     }%
560     \ifdim\var@@temp@spread<\z@ \advance\@tempdimb 1\p@ \repeat
561     \wlog{- LAST -%
562         ^^JExtra skip:\the\var@@temp@spread
563         ^^JLeft:\the\ht\flushend@@tempbox@c/\the\dp\flushend@@tempbox@c
564         ^^JRight:\the\ht\flushend@@varbox@c/\the\dp\flushend@@varbox@c
565         ^^JOutput:\the\@tempdimb
566         }%
567     \setbox\flushend@@tempbox@c\vsplit\@tempboxa to\@tempdimb
568     \setbox\flushend@@varbox@c\vbox{\unvbox\flushend@@tempbox@c}%
569     \setbox\@leftcolumn\vbox to\@tempdima{%
570         \vbox to\@tempdimb{\unvbox\flushend@@varbox@c\vss}%
571         \hrule\@height\flushend@@page@rule width\textwidth
572         \vskip-\flushend@@page@rule
573         \hrule\@height\z@ width\textwidth
574         \vss
575         }%
576     \global\ht\@leftcolumn=\the\@tempdima
577     \ifdim\top@@floatbox@skip>\z@
578         \setbox\@outputbox\vbox to\@tempdima{%
579             \if@right@column@spread
580                 \vbox spread\var@@temp@spread{%
581                     \unvbox\@outputbox
582                     \vskip\top@@floatbox@skip
583                     \unvbox\@tempboxa
584                     }%
585             \else
586                 \vbox spread\var@@temp@spread{%
587                     \unvbox\@outputbox
588                     \vskip\top@@floatbox@skip
589                     \unvbox\@tempboxa
590                     \vss
591                     }%
592             \fi
593             \vss
594             }%
595     \else
596         \setbox\@outputbox\vbox to\@tempdima{%
597             \if@right@column@spread
```

15

```
598            \vbox spread\var@@temp@spread{%
599                \unvbox\@tempboxa
600                }%
601        \else
602            \vbox spread\var@@temp@spread{%
603                \unvbox\@tempboxa
604                \vss
605                }%
606        \fi
607        \vss
608        }%
609    \fi
610    }
```

\last@outputdblcol@modern   Columns balancing of the twocolumn mode page (modern algorithm). It is maybe
not so safe for text moving or missing at all as it uses some heuristic technique
to find footnotes, last skip between lines at left column and floats or section like
heads at right column top for replacing them (except heads of course) to other
places in text.

```
611 \def\last@outputdblcol@modern{%
612    \if@firstcolumn
613        \global \@firstcolumnfalse
614        \global\setbox\@leftcolumn\copy\@outputbox
615        \splitmaxdepth\maxdimen
616        \vbadness\maxdimen
617        \setbox\@outputbox\vbox{\unvbox\@outputbox\unskip}%
618        \setbox\@outputbox\vsplit\@outputbox to\maxdimen
619        \toks@\expandafter{\topmark}%
620        \xdef\@firstcoltopmark{\the\toks@}%
621        \toks@\expandafter{\splitfirstmark}%
622        \xdef\@firstcolfirstmark{\the\toks@}%
623        \ifx\@firstcolfirstmark\@empty
624            \global\let\@setmarks\relax
625        \else
626            \gdef\@setmarks{%
627                \let\firstmark\@firstcolfirstmark
628                \let\topmark\@firstcoltopmark
629                }%
630        \fi
631    \else
632        \global \@firstcolumntrue
633        \@tempdima\ht\@leftcolumn
634        \advance\@tempdima by\dp\@leftcolumn
635        \set@split@topskip@to\topskip
636        \var@@temp@spread=\wd\@outputbox
637        \get@@footnoterule@@box
638        \xdef\main@box@height{\the\ht\@leftcolumn}%
639        \xdef\main@box@skip{\z@}%
640        \reset@check@@baselineskip@@skip\relax\relax\flushend@@lastskip@c
```

```
641        \setbox\flushend@@varbox@a\vbox{\unvcopy\@leftcolumn}%
642        \var@@loop@iter\z@ \var@@temp@loop\z@
643        \analyze@leftcolumn@box\flushend@@varbox@a
644        \setbox\flushend@@varbox@a\vbox{\unvcopy\@outputbox}%
645        \var@@loop@iter\z@ \var@@temp@loop\z@
646        \analyze@rightcolumn@box\flushend@@varbox@a
647        \ifdim\main@box@skip>\z@
648            %% footnote in left column
649            \set@split@topskip@to\z@
650            \setbox\flushend@@varbox@a\vsplit\@leftcolumn to\main@box@height
651        \else
652            %% no footnote in left column
653            \setbox\flushend@@varbox@a\box\@leftcolumn
654        \fi
655        \ifdim\var@@temp@spread>\z@
656            %% rightcolumn non empty
657            \combine@columns@for@balance
658        \else
659            %% rightcolumn empty
660            \setbox\@tempboxa\vbox{%
661                \unvbox\flushend@@varbox@a
662                \remove@lastbox@at@balancing
663                \the\atColsEnd
664                }%
665        \fi
666        \ifdim\main@box@skip>\z@
667            %% footnote in left column
668            \set@outputbox@with@footnote
669        \else
670            %% no footnote in left column
671            \set@outputbox@without@footnote
672        \fi
673        \setbox\@outputbox \vbox {%
674            \hb@xt@\textwidth {%
675                \hb@xt@\columnwidth {%
676                    \fmt@box@adds{\box\@leftcolumn}\hss}%
677                    \hfil
678                    \vrule \@width\columnseprule
679                    \hfil
680                    \hb@xt@\columnwidth {%
681                        \fmt@box@adds{\box\@outputbox}\hss}%
682                        }%
683                }%
684        \global\let\@outputdblcol\saved@orig@@outputdblcol
685        \global\atColsEnd{}%
686        \ifvoid\hold@viper
687        \else
688            \setbox\@outputbox\vbox{\box\hold@viper\box\@outputbox}%
689        \fi
690        \@combinedblfloats
```

```
691          \csname @setmarks\endcsname
692          \@outputpage
693          \begingroup
694              \@dblfloatplacement
695              \@startdblcolumn
696              \@whilesw\if@fcolmade\fi
697                  {\@outputpage\@startdblcolumn}%
698              \ifvoid\@viper
699              \else
700                  \global\setbox\@viper\vbox{%
701                      \vskip-\stripsep
702                      \unvbox\@viper
703                      }%
704                  \csname @viperoutput\endcsname
705              \fi
706          \endgroup
707      \fi
708      }
```

\last@outputdblcol@old   Columns balancing of the twocolumn mode page (ancient algorithm). It is maybe
not so good in some cases but maybe more safe for text moving or missing at all.

```
709 \def\last@outputdblcol@ancient{%
710     \if@firstcolumn
711         \global\@firstcolumnfalse
712         \global\setbox\@leftcolumn\box\@outputbox
713     \else
714         \global\@firstcolumntrue
715         \@tempdima\ht\@leftcolumn
716         \set@split@topskip@to\topskip
717         \if@auto@baselineskip
718             \setbox\@tempboxa\vbox{%
719                 \unvcopy\@leftcolumn
720                 \global\flushend@@lastskip@c\lastskip
721                 \global\flushend@@lastskip@b\lastskip
722                 \loop
723                     \global\flushend@@lastskip@a\flushend@@lastskip@b
724                     \unskip\unpenalty
725                     \global\flushend@@lastskip@b\lastskip
726                     \global\advance\flushend@@lastskip@c by\lastskip
727                 \ifdim\flushend@@lastskip@b=-\flushend@@lastskip@a
728                     \global\advance\flushend@@lastskip@c by-\lastskip
729                 \else
730                 \repeat
731                 \ifdim\flushend@@lastskip@b=-\flushend@@lastskip@a
732                     \ifdim\flushend@@lastskip@b=\z@
733                         \setbox\flushend@@varbox@a\lastbox
734                         \global\advance\flushend@@lastskip@c by\ht\flushend@@varbox@a
735                         \global\advance\flushend@@lastskip@c by\lastskip
736                         \unskip\unpenalty
737                         \setbox\flushend@@varbox@a\lastbox
```

18

```
738                        \global\advance\flushend@@lastskip@c by\dp\flushend@@varbox@a
739                    \else
740                        \global\flushend@@lastskip@c\lastskip
741                        \global\advance\flushend@@lastskip@c by\topskip
742                    \fi
743                \fi
744                \global\advance\flushend@@lastskip@c by-\topskip
745                }%
746            \setbox\@tempboxa\vbox{%
747                \unvbox\@leftcolumn
748                \unskip\unpenalty
749                \vskip\flushend@@lastskip@c
750                \hrule\@height\flushend@@page@rule width\columnwidth
751                \vskip-\flushend@@page@rule
752                \hrule\@height\z@ width\textwidth
753                \the\atColsBreak
754                \unvbox\@outputbox
755                \remove@lastbox@at@balancing
756                \the\atColsEnd
757            }%
758        \else
759            \setbox\@tempboxa\vbox{%
760                \unvbox\@leftcolumn
761                \setbox\z@\lastbox
762                \unskip
763                \hrule\@height\flushend@@page@rule width\columnwidth
764                \vskip-\flushend@@page@rule
765                \hrule\@height\z@ width\textwidth
766                \the\atColsBreak
767                \unvbox\@outputbox
768                \remove@lastbox@at@balancing
769                \the\atColsEnd
770                }%
771        \fi
772        \@tempdimb .5\ht\@tempboxa
773        \loop
774            \setbox\flushend@@tempbox@a\copy\@tempboxa
775            \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
776                \vsplit\flushend@@tempbox@a to\@tempdimb
777                \vss
778                \vsplit\flushend@@tempbox@a to\@tempdimb
779                }%
780            \wlog{Extra height:\the\ht\flushend@@tempbox@a\space when \the\@tempdimb}%
781        \ifvoid\flushend@@tempbox@a
782        \else
783            \advance\@tempdimb 1\p@
784        \repeat
785        \loop
786            \setbox\flushend@@tempbox@a\copy\@tempboxa
787            \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
```

```
788                     \vsplit\flushend@@tempbox@a to\@tempdimb
789                     \vss
790                     }%
791                 \wlog{(2)Left:\the\ht\flushend@@tempbox@c\space
792                     Right:\the\ht\flushend@@tempbox@a\space
793                     Output:\the\@tempdimb
794                 }%
795             \ifdim\ht\flushend@@tempbox@c<\ht\flushend@@tempbox@a
796                 \@tempdimb=\the\ht\flushend@@tempbox@a
797             \repeat
798             \wlog{- LAST -^^JExtra skip: \the\z@
799                     ^^JLeft:\the\ht\flushend@@tempbox@c
800                     ^^JRight:\the\ht\flushend@@tempbox@a
801                     ^^JOutput:\the\@tempdimb
802             }%
803             \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
804                 \vsplit\@tempboxa to\@tempdimb
805                 \vss
806                 }%
807             \setbox\@leftcolumn\vbox to\@tempdima{%
808                 \fmt@vbox@adds[\columnwidth]{%
809                     \vbox to\@tempdimb{%
810                         \unvbox
811                         \flushend@@tempbox@c
812                         }%
813                     }%
814                 \hrule\@height\flushend@@page@rule
815                 \vskip-\flushend@@page@rule
816                 \hrule\@height\z@ width\textwidth
817                 \vss
818                 }%
819             \setbox\@outputbox\vbox to\@tempdima{%
820                 \fmt@vbox@adds[\columnwidth]{%
821                     \vbox to\@tempdimb{%
822                         \unvbox\@tempboxa
823                         \vskip\z@
824                         }%
825                     }%
826                 \hrule\@height\flushend@@page@rule
827                 \vskip-\flushend@@page@rule
828                 \hrule\@height\z@ width\textwidth
829                 \vss
830                 }%
831             \setbox\@outputbox\vbox{%
832                 \hb@xt@\textwidth{%
833                     \hb@xt@\columnwidth{\box\@leftcolumn\hss}%
834                     \hfil
835                     \vrule \@width\columnseprule
836                     \hfil
837                     \hb@xt@\columnwidth{\box\@outputbox\hss}%
```

```
838              }%
839            }%
840        \global\let\@outputdblcol\saved@orig@@outputdblcol
841        \global\atColsEnd{}%
842        \ifvoid\hold@viper
843        \else
844            \setbox\@outputbox\vbox{\box\hold@viper\box\@outputbox}%
845        \fi
846        \@combinedblfloats
847        \@outputpage
848        \begingroup
849            \@dblfloatplacement
850            \@startdblcolumn
851            \@whilesw\if@fcolmade\fi
852                {\@outputpage\@startdblcolumn}%
853            \ifvoid\@viper
854            \else
855                \global\setbox\@viper\vbox{%
856                    \vskip-\stripsep
857                    \unvbox\@viper
858                    }%
859                \csname @viperoutput\endcsname
860            \fi
861        \endgroup
862    \fi
863    }
```

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

```
864 \usepackage{etoolbox}
865 \AtBeginDocument{%
866     \global\let\saved@orig@@outputdblcol\@outputdblcol
867     \if@ancient@balance@version
868         \global\let\last@outputdblcol\last@outputdblcol@ancient
869     \else
870         \global\let\last@outputdblcol\last@outputdblcol@modern
871     \fi
872     \global\let\balanced@@outputdblcol\last@outputdblcol
873     \preto\enddocument{\let\@outputdblcol\balanced@@outputdblcol}%
874     \appto\footnoterule{\vskip\z@}%
875     }
```

User interface commands for the balancing pages.

\flushcolsend is used to switch on column balancing on the current page.

```
876 \def\flushcolsend{\global\let\@outputdblcol\last@outputdblcol}
```

\raggedcolsend is used to switch off column balancing on the current page.

```
877 \def\raggedcolsend{\global\let\@outputdblcol\saved@orig@@outputdblcol}
```

\flushend is used to switch on column balancing on the last page. It is used by default.

878 `\def\flushend{\global\let\balanced@@outputdblcol\last@outputdblcol}`

`\raggedend` is used to switch off column balancing on the last page.

879 `\def\raggedend{\global\let\balanced@@outputdblcol\saved@orig@@outputdblcol}`

In the case to see some debug information `debug` option is used and it is possible to see how package calculates dimensions of balanced columns by additional rules on balanced page and some log records in log file.

880 `\if@balance@debug`
881 `    \showcolsendrule`
882 `\fi`