

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.

<code>\flushend</code>	This macro switches on column balancing on the last page. It is used by default.
<code>\raggedend</code>	This macro switches off column balancing on the last page.
<code>\flushcolsend</code>	This macro switches on column balancing on the current page.
<code>\raggedcolsend</code>	This macro switches off column balancing on the current page.
<code>\atColsBreak</code>	<code>{\tokens}</code> Adds <code>\tokens</code> in place of the original column break (made without balancing). <i>Example:</i> <code>\atColsBreak{\vskip-2pt}</code>
<code>\atColsEnd</code>	<code>{\tokens}</code> Adds <code>\tokens</code> at the end of right column. <i>Example:</i> <code>\atColsEnd{\vfil}</code> .
<code>\showcolsendrule</code>	It can be used just for debugging: adds rule to the bottom of columns.

2.1 Package options

<code>ancient</code>	It is used to switch on old version of balancing algorithm. This version is not so accurate or "clever" but quite safe.
<code>modern</code>	[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.
<code>autobase</code>	[default] It is used to guess <code>\baselineskip</code> value on original columns break. On failure just use <code>\atColsBreak{...}</code> .
<code>noautobase</code>	It is used to switch off the previous option behaviour.
<code>spread</code>	[default] It adds extra glue to the rightcolumn trying to balance.
<code>nospread</code>	It skips adding extra glue to the last column.
<code>removelastbox</code>	[default] It tries to remove an empty box (some more material) from the last column bottom.
<code>keeplastbox</code>	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.
<code>checkfootnote</code>	[default] Adds guess for footnote on left column then modern balancing algorithm is in use.
<code>nocheckfootnote</code>	Skips guess for footnote then modern balancing algorithm is in use.
<code>checkfloat</code>	[default] Adds guess for top float on right column then modern balancing algorithm is in use.
<code>nocheckfloat</code>	Skips guess for top float on right column then modern balancing algorithm is in use.
<code>debug</code>	Adds rules to the bottom of columns (just for debugging) and leftcolumn break place. Adds some additional log info.
<code>nodebug</code>	[default] Skips putting debugging 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{nocodebug}{\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 \newdimen\flushend@@lastkern@a
44 \newdimen\var@@temp@spread
45 \newdimen\var@@temp@a
46 \def\top@@skip@@limit{.7\topskip}
47 \newdimen\flushend@@page@rule \flushend@@page@rule\z@
48 \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.
49 \gdef\top@@floatbox@min@default{4\topskip}
50 \let\top@@floatbox@min\top@@floatbox@min@default

51 \newbox\flushend@@varbox@a
52 \newbox\flushend@@varbox@c
53 \newbox\flushend@@tempbox@a
54 \newbox\flushend@@tempbox@c
55 \ifundefined{@viper}{\newbox\@viper}{}
```

```

56 \@ifundefined{hold@viper}{\newbox\hold@viper}{}
57 \newtoks\atColsBreak \atColsBreak={}
58 \newtoks\atColsEnd \atColsEnd={}
59 \@ifundefined{fmt@box@adds}{\def\fmt@box@adds#1{#1}}{}
60 \@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.

```

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

```

Macros used in debug mode.

```

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

```

93 \gdef\analyze@lastbox@box#1{%
94   \setbox\flushend@@varbox@a\vbox{%
95     \unvbox#1%

```

```

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

```

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

```

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

```

```

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

```

```

187         \else
188             \wlog@balance@debug{lastbox: \log@box@info{\flushend@@varbox@a}}%
189         \fi
190     \fi
191     \ifdim\ht\flushend@@varbox@a>\topskip
192         \expandafter\analyze@leftcolumn@box\expandafter\flushend@@varbox@a
193     \fi
194 \fi
195 }

```

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

```

196 \def\get@@footnoterule@@box{%
197     \set@split@topskip@to@z@
198     \setbox\flushend@@varbox@a\vbox{\strut
199         \vskip\z@
200         \footnoterule
201         \unskip\unkern\unpenalty
202         \unskip\unkern\unpenalty
203     }%
204     \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\p@
205     \xdef\footnoterule@@@box@@ht{\the\ht\flushend@@varbox@a}%
206     \xdef\footnoterule@@@box@@dp{\the\dp\flushend@@varbox@a}%
207     \xdef\footnoterule@@@box@@wd{\the\wd\flushend@@varbox@a}%
208     \wlog@balance@debug{:footnoterule: \log@box@info{\flushend@@varbox@a}}%
209     \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@varbox@a}%
210 }

```

`\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`.

```

211 \long\def@gobblethree#1#2#3{}
212 \def\check@@footnoterule@@box#1#2#3{%
213     \ifdim\ht#1=\footnoterule@@@box@@ht
214         \ifdim\dp#1=\footnoterule@@@box@@dp
215             \ifdim\wd#1=\footnoterule@@@box@@wd
216                 \ifdim#2=\topskip
217                     \else
218                         \xdef\main@box@height{\the\ht#3}%
219                         \xdef\main@box@skip{\the#2}%
220                         \wlog@balance@debug{^^J:footnoterule found:
221                             main@box <ht=\main@box@height,
222                             skip=\main@box@skip>
223                         }%
224                     \global\let\check@@footnoterule@@box@gobblethree
225                     \global\let\check@@@baselineskip@@@skip\reset@check@@@baselineskip@@@skip
226                 \fi

```

```

227         \fi
228     \fi
229     \fi
230 }
231 \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.

232 \def\check@@baselineskip@@skip#1#2#3{%
233     \ifdim#1>\z@
234         \ifdim#2>\z@
235             \global#3=\the#1%
236             \global\let\check@@baselineskip@@skip\gobblethree
237         \fi
238     \fi
239 }
240 \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 acti-
    vates \check@@baselineskip@@skip.

241 \def\reset@check@@baselineskip@@skip#1#2#3{%
242     \global#3=\z@
243     \global\let\check@@baselineskip@@skip\initial@check@@baselineskip@@skip
244 }

\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



245 \def\analyze@rightcolumn@box#1{%
246     \bgroup
247         \xdef\top@@floatbox@ht{\z@}%
248         \xdef\top@@floatbox@skip{\z@}%
249         \xdef\top@@section@skip{\z@}%
250         \set@split@topskip@to\z@
251         \setbox\flushend@@varbox@a\vbox{\strut
252             \vskip\z@
253             \unvcopy#1%
254         }%
255         \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\p@
256         \wlog@balance@debug{^^J(R)mainbox: \log@box@info{#1}}%

```



```

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

```

```

307         \ifdim\ht\flushend@@tempbox@c>\z@
308             \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
309         \fi
310     \flushend@@lastskip@b\ht\flushend@@varbox@a
311     \var@@temp@a=3\p@
312     \loop
313         \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
314         \ifvoid\flushend@@tempbox@c
315             \advance \var@@temp@a 3\p@
316             \ifdim\var@@temp@a>\flushend@@lastskip@b
317                 \var@@temp@a=-1\p@
318             \fi
319         \else
320             \ifdim\ht\flushend@@tempbox@c<\z@
321                 \else
322                     \var@@temp@a=-1\p@
323                 \fi
324             \fi
325     \ifdim \var@@temp@a>\z@
326     \repeat
327     \loop
328         \setbox\flushend@@varbox@a\vbox{%
329             \unvbox\flushend@@tempbox@c
330             \unskip\unkern\unpenalty
331             \unskip\unkern\unpenalty
332             \unskip\unkern\unpenalty
333             \setbox\flushend@@tempbox@c\lastbox
334             }%
335     \flushend@@lastskip@b\ht\flushend@@varbox@a
336     \setbox\flushend@@varbox@a\vbox{%
337         \unvbox\flushend@@varbox@a
338         \unskip\unkern\unpenalty
339         \unskip\unkern\unpenalty
340         \unskip\unkern\unpenalty
341         }%
342     \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
343     \ifdim\flushend@@lastskip@b>\topskip
344         \xdef\top@@section@skip{\the\flushend@@lastskip@b}%
345     \fi
346     \ifdim\ht\flushend@@varbox@a>2\topskip
347         \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@varbox@a}%
348     \repeat
349     \fi
350     \fi
351     \egroup
352     }

```

`\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.

```

353 \def\combine@columns@for@balance{%
354     \setbox\@outputbox\vbox{\strut
355         \vskip\z@
356         \unvbox\@outputbox
357     }%
358     \set@split@topskip@to\z@
359     \setbox\flushend@@tempbox@c\vsplit\@outputbox to\p@
360     \if@auto@baselineskip
361         %% Trying guess baselineskip value on column break
362         \ifdim\top@@floatbox@skip>\z@
363             \setbox\flushend@@tempbox@c\vsplit\@outputbox to\top@@floatbox@ht
364             \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
365         \fi
366         \setbox\@tempboxa\vbox{%
367             \unvbox\flushend@@varbox@a
368             \unskip\unkern\unpenalty
369             \vskip\flushend@@lastskip@c
370             \the\atColsBreak
371             \hrule\@height\flushend@@page@rule width\columnwidth
372             \ifdim\top@@section@skip>\top@@skip@limit
373                 \vskip\top@@section@skip
374             \fi
375             \unvbox\@outputbox
376             \remove@lastbox@at@balancing
377             \the\atColsEnd
378         }%
379         \ifdim\top@@floatbox@skip>\z@
380             \setbox\@outputbox\vbox{\unvbox\flushend@@tempbox@c}%
381         \fi
382     \else
383         %% Ignore baselineskip value on column break
384         \setbox\@tempboxa\vbox{%
385             \unvbox\@leftcolumn
386             \setbox\z@\lastbox
387             \unskip\unkern\unpenalty
388             \the\atColsBreak
389             \hrule\@height\flushend@@page@rule width\columnwidth
390             \unvbox\@outputbox
391             \remove@lastbox@at@balancing
392             \the\atColsEnd
393         }%
394     \fi
395 }

```

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

```

396 \def\set@outputbox@with@footnote{%
397     %% footnote in left column
398     \@tempdimb\ht\@tempboxa
399     \ifdim\top@@floatbox@skip>\z@

```

```

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

```

```

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

```

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

```

497 \def\set@outputbox@without@footnote{%
498   %% no footnote in left column
499   \@tempdimb \ht\@tempboxa
500   \ifdim\top@@floatbox@skip>\z@
501     \advance\@tempdimb \top@@floatbox@skip
502     \advance\@tempdimb \top@@floatbox@ht
503   \fi
504   \@tempdimb .5\@tempdimb
505   \set@split@topskip@to\topskip
506   \loop
507     \setbox\flushend@@varbox@a\copy\@tempboxa
508     \setbox\flushend@@tempbox@a\vsplit\flushend@@varbox@a to\@tempdimb
509     \setbox\flushend@@tempbox@c\ vbox{\unvcopy\flushend@@tempbox@a}%
510     \ifdim\top@@floatbox@skip>\z@
511       \setbox\flushend@@varbox@c\ vbox{%
512         \unvcopy\@outputbox
513         \vskip\top@@floatbox@skip
514         \unvbox\flushend@@varbox@a
515       }%
516     \else
517       \setbox\flushend@@varbox@c\ vbox{\unvbox\flushend@@varbox@a}%
518     \fi
519     \var@@temp@spread=\ht\flushend@@tempbox@c
520     \advance\var@@temp@spread by\dp\flushend@@tempbox@c
521     \advance\var@@temp@spread by-\ht\flushend@@varbox@c
522     \advance\var@@temp@spread by-\dp\flushend@@varbox@c
523     \wlog@balance@debug{Left x: \the\ht\flushend@@tempbox@a
524       +\the\dp\flushend@@tempbox@a=\the\ht\flushend@@varbox@a
525       +\the\dp\flushend@@varbox@a:\the\@tempdimb
526       ^^JLeft 0: \the\ht\flushend@@tempbox@c
527       +\the\dp\flushend@@tempbox@c:\the\@tempdimb
528       ^^JRight x: \the\ht\flushend@@varbox@c
529       +\the\dp\flushend@@varbox@c=\the\ht\flushend@@varbox@a
530       +\the\dp\flushend@@varbox@a:\the\@tempdimb
531       ^^JExtra height:\the\var@@temp@spread\space when \the\@tempdimb
532     }%
533   \ifdim\var@@temp@spread<\z@ \advance\@tempdimb 1\p@ \repeat
534   \wlog{- LAST -%
535     ^^JExtra skip:\the\var@@temp@spread
536     ^^JLeft:\the\ht\flushend@@tempbox@c/\the\dp\flushend@@tempbox@c
537     ^^JRight:\the\ht\flushend@@varbox@c/\the\dp\flushend@@varbox@c
538     ^^JOutput:\the\@tempdimb
539   }%
540   \setbox\flushend@@tempbox@c\vsplit\@tempboxa to\@tempdimb
541   \setbox\flushend@@varbox@c\ vbox{\unvbox\flushend@@tempbox@c}%
542   \setbox\@leftcolumn\ vbox to\@tempdima{%
543     \vbox to\@tempdimb{\unvbox\flushend@@varbox@c\vss}%
544     \hrule\@height\flushend@@page@rule width\textwidth
545     \vss
546   }%

```

```

547 \global\ht\@leftcolumn=\the\@tempdima
548 \ifdim\top@@floatbox@skip>\z@
549   \setbox\@outputbox\vbox to\@tempdima{%
550     \if@right@column@spread
551       \vbox spread\var@@temp@spread{%
552         \unvbox\@outputbox
553         \vskip\top@@floatbox@skip
554         \unvbox\@tempboxa
555       }%
556     \else
557       \vbox spread\var@@temp@spread{%
558         \unvbox\@outputbox
559         \vskip\top@@floatbox@skip
560         \unvbox\@tempboxa
561         \vss
562       }%
563     \fi
564     \vss
565   }%
566 \else
567   \setbox\@outputbox\vbox to\@tempdima{%
568     \if@right@column@spread
569       \vbox spread\var@@temp@spread{%
570         \unvbox\@tempboxa
571       }%
572     \else
573       \vbox spread\var@@temp@spread{%
574         \unvbox\@tempboxa
575         \vss
576       }%
577     \fi
578     \vss
579   }%
580 \fi
581 }

```

`\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.

```

582 \def\last@outputdblcol@modern{%
583   \if@firstcolumn
584     \global \@firstcolumnfalse
585     \global \setbox\@leftcolumn \box\@outputbox
586   \else
587     \global \@firstcolumntrue
588     \@tempdima\ht\@leftcolumn
589     \set@split@topskip@to\topskip

```

```

590 \var@@temp@spread=\wd\@outputbox
591 \get@@footnoterule@@box
592 \xdef\main@box@height{\the\ht\@leftcolumn}%
593 \xdef\main@box@skip{\z@}%
594 \global\flushend@@lastskip@c\z@
595 \setbox\flushend@@varbox@a\ vbox{\unvcopy\@leftcolumn}%
596 \analyze@leftcolumn@box\flushend@@varbox@a
597 \setbox\flushend@@varbox@a\ vbox{\unvcopy\@outputbox}%
598 \analyze@rightcolumn@box\flushend@@varbox@a
599 \ifdim\main@box@skip>\z@
600     %% footnote in left column
601     \set@split@topskip@to\z@
602     \setbox\flushend@@varbox@a\ vsplit\@leftcolumn to\main@box@height
603 \else
604     %% no footnote in left column
605     \setbox\flushend@@varbox@a\ box\@leftcolumn
606 \fi
607 \ifdim\var@@temp@spread>\z@
608     %% rightcolumn non empty
609     \combine@columns@for@balance
610 \else
611     %% rightcolumn empty
612     \setbox\@tempboxa\ vbox{%
613         \unvbox\flushend@@varbox@a
614         \remove@lastbox@at@balancing
615         \the\atColsEnd
616     }%
617 \fi
618 \ifdim\main@box@skip>\z@
619     %% footnote in left column
620     \set@outputbox@with@footnote
621 \else
622     %% no footnote in left column
623     \set@outputbox@without@footnote
624 \fi
625 \setbox\@outputbox \vbox {%
626     \hb@xt@\textwidth {%
627         \hb@xt@\columnwidth {%
628             \fmt@box@adds{\box\@leftcolumn}\hss}%
629             \hfil
630             \vrule \@width\columnseprule
631             \hfil
632             \hb@xt@\columnwidth {%
633                 \fmt@box@adds{\box\@outputbox}\hss}%
634                 }%
635         }%
636 \global\let\@outputdblcol\saved@orig@@outputdblcol
637 \global\atColsEnd{}%
638 \ifvoid\hold@vipier
639 \else

```



```

640         \setbox\@outputbox\vbox{\box\hold@viper\box\@outputbox}%
641     \fi
642     \@combinedblfloats
643     \@outputpage
644     \begingroup
645         \@dblfloatplacement
646         \@startdblcolumn
647         \@whilesw\if@colmade\fi
648         {\@outputpage\@startdblcolumn}%
649         \ifvoid\@viper
650         \else
651             \global\setbox\@viper\vbox{%
652                 \vskip-\stripsep
653                 \unvbox\@viper
654             }%
655             \csname @viperoutput\endcsname
656         \fi
657     \endgroup
658 \fi
659 }

```

\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.

```

660 \def\last@outputdblcol@ancient{%
661     \if@firstcolumn
662         \global\@firstcolumnfalse
663         \global\setbox\@leftcolumn\box\@outputbox
664     \else
665         \global\@firstcolumntrue
666         \@tempdima\ht\@leftcolumn
667         \set@split@topskip@to\topskip
668         \if@auto@baselineskip
669             \setbox\@tempboxa\vbox{%
670                 \unvcopy\@leftcolumn
671                 \global\flushend@@lastskip@c\lastskip
672                 \global\flushend@@lastskip@b\lastskip
673             \loop
674                 \global\flushend@@lastskip@a\flushend@@lastskip@b
675                 \unskip\unpenalty
676                 \global\flushend@@lastskip@b\lastskip
677                 \global\advance\flushend@@lastskip@c by\lastskip
678                 \ifdim\flushend@@lastskip@b=-\flushend@@lastskip@a
679                     \global\advance\flushend@@lastskip@c by-\lastskip
680                 \else
681                 \repeat
682                 \ifdim\flushend@@lastskip@b=-\flushend@@lastskip@a
683                     \ifdim\flushend@@lastskip@b=\z@
684                         \setbox\flushend@@varbox@a\lastbox
685                         \global\advance\flushend@@lastskip@c by\ht\flushend@@varbox@a
686                     \global\advance\flushend@@lastskip@c by\lastskip

```

```

687         \unskip\unpenalty
688         \setbox\flushend@@varbox@a\lastbox
689         \global\advance\flushend@@lastskip@c by\dp\flushend@@varbox@a
690     \else
691         \global\flushend@@lastskip@c\lastskip
692         \global\advance\flushend@@lastskip@c by\topskip
693     \fi
694 \fi
695 \global\advance\flushend@@lastskip@c by-\topskip
696 }%
697 \setbox\@tempboxa\vbox{%
698     \unvbox\@leftcolumn
699     \unskip\unpenalty
700     \vskip\flushend@@lastskip@c
701     \hrule\@height\flushend@@page@rule width\columnwidth
702     \the\atColsBreak
703     \unvbox\@outputbox
704     \remove@lastbox@at@balancing
705     \the\atColsEnd
706 }%
707 \else
708     \setbox\@tempboxa\vbox{%
709         \unvbox\@leftcolumn
710         \setbox\z@\lastbox
711         \unskip
712         \hrule\@height\flushend@@page@rule width\columnwidth
713         \the\atColsBreak
714         \unvbox\@outputbox
715         \remove@lastbox@at@balancing
716         \the\atColsEnd
717     }%
718 \fi
719 \@tempdimb .5\ht\@tempboxa
720 \loop
721     \setbox\flushend@@tempbox@a\copy\@tempboxa
722     \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
723         \vsplit\flushend@@tempbox@a to\@tempdimb
724         \vss
725         \vsplit\flushend@@tempbox@a to\@tempdimb
726     }%
727     \wlog{Extra height:\the\ht\flushend@@tempbox@a\space when \the\@tempdimb}%
728 \ifvoid\flushend@@tempbox@a
729 \else
730     \advance\@tempdimb 1\p@
731 \repeat
732 \loop
733     \setbox\flushend@@tempbox@a\copy\@tempboxa
734     \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
735         \vsplit\flushend@@tempbox@a to\@tempdimb
736         \vss

```

```

737         }%
738         \wlog{(2)Left:\the\ht\flushend@@tempbox@c\space
739             Right:\the\ht\flushend@@tempbox@a\space
740             Output:\the\@tempdimb
741         }%
742     \ifdim\ht\flushend@@tempbox@c<\ht\flushend@@tempbox@a
743         \@tempdimb=\the\ht\flushend@@tempbox@a
744     \repeat
745     \wlog{- LAST -^^JExtra skip: \the\z@
746             ^^JLeft:\the\ht\flushend@@tempbox@c
747             ^^JRight:\the\ht\flushend@@tempbox@a
748             ^^JOutput:\the\@tempdimb
749     }%
750     \setbox\flushend@@tempbox@c\vbox to\@tempdimb{%
751         \vsplit\@tempboxa to\@tempdimb
752         \vss
753     }%
754     \setbox\@leftcolumn\vbox to\@tempdima{%
755         \fmt\vbox@adds[\columnwidth]{%
756             \vbox to\@tempdimb{%
757                 \unvbox
758                 \flushend@@tempbox@c
759             }%
760         }%
761         \hrule\@height\flushend@@page@rule
762         \vss
763     }%
764     \setbox\@outputbox\vbox to\@tempdima{%
765         \fmt\vbox@adds[\columnwidth]{%
766             \vbox to\@tempdimb{%
767                 \unvbox\@tempboxa
768                 \vskip\z@
769             }%
770         }%
771         \hrule\@height\flushend@@page@rule
772         \vss
773     }%
774     \setbox\@outputbox\vbox{%
775         \hb@xt@\textwidth{%
776             \hb@xt@\columnwidth{\box\@leftcolumn\hss}%
777             \hfil
778             \vrule \@width\columnseprule
779             \hfil
780             \hb@xt@\columnwidth{\box\@outputbox\hss}%
781         }%
782     }%
783     \global\let\@outputdblcol\saved@orig@@outputdblcol
784     \global\atColsEnd{}%
785     \ifvoid\hold@vipper
786     \else

```

```

787         \setbox\@outputbox\vbox{\box\hold@viper\box\@outputbox}%
788     \fi
789     \@combinedblfloats
790     \@outputpage
791     \begingroup
792         \@dblfloatplacement
793         \@startdblcolumn
794         \@whilesw\if@fcolmade\fi
795         {\@outputpage\@startdblcolumn}%
796         \ifvoid\@viper
797         \else
798             \global\setbox\@viper\vbox{%
799                 \vskip-\stripsep
800                 \unvbox\@viper
801             }%
802         \csname @viperoutput\endcsname
803     \fi
804 \endgroup
805 \fi
806 }

```

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

```

807 \usepackage{etoolbox}
808 \AtBeginDocument{%
809     \global\let\saved@orig@@outputdblcol\@outputdblcol
810     \if@ancient@balance@version
811         \global\let\last@outputdblcol\last@outputdblcol@ancient
812     \else
813         \global\let\last@outputdblcol\last@outputdblcol@modern
814     \fi
815     \global\let\balanced@@outputdblcol\last@outputdblcol
816     \preto\enddocument{\let\@outputdblcol\balanced@@outputdblcol}%
817     \appto\footnoterule{\vskip\z@}%
818 }

```

User interface commands for the balancing pages.

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

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

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

```
820 \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.

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

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

```
822 \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.

```
823 \if@balance@debug
824     \showcolsendrule
825 \fi
```