

# The `flushend` package

Sigitas Tolušis  
`sigitas@vtex.lt`

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## 1 Introduction

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

## 2 Usage

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

<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>autobase</code>	It is used to guess <code>\baselineskip</code> value on original columns break.
<code>noauto</code>	It is used to switch off the previous option behaviour.
<code>debug</code>	Adds rules to the bottom of columns (just for debugging) and leftcolumn break place. Adds some additional log info.

## 3 Implementation

```

1 \newif\if@auto@baselineskip \@auto@baselineskiptrue
2 \newif\if@balance@debug \@balance@debugfalse
3 \DeclareOption{autobase}{\global\@auto@baselineskiptrue}
4 \DeclareOption{noauto}{\global\@auto@baselineskipfalse}
5 \DeclareOption{debug}{\global\@balance@debugtrue}
6 \DeclareOption{nodebug}{\global\@balance@debugfalse}
7 \ProcessOptions

8 \newskip\flushend@@lastskip@a
9 \newskip\flushend@@lastskip@b
10 \newskip\flushend@@lastskip@c
11 \newcount\flushend@@penalty@a
12 \newdimen\flushend@@lastkern@a
13 \newdimen\var@@temp@spread
14 \newdimen\var@@temp@a
15 \newdimen\flushend@@page@rule \flushend@@page@rule\z@
16 \def\showcolsendrule{\global\flushend@@page@rule=.4pt}

\top@@floatbox@min {(float size)} This value is used to catch possible float on right column top.
17 \gdef\top@@floatbox@min{4\topskip}

18 \newbox\flushend@@varbox@a
19 \newbox\flushend@@varbox@c
20 \newbox\flushend@@tempbox@a
21 \newbox\flushend@@tempbox@c
22 \@ifundefined{viper}{\newbox\viper}{}
23 \@ifundefined{hold@viper}{\newbox\hold@viper}{}

24 \newtoks\atColsBreak \atColsBreak={}
25 \newtoks\atColsEnd \atColsEnd={}

26 \@ifundefined{fmt@box@adds}{\def\fmt@box@adds#1{#1}}{}
27 \@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.
28 \gdef\remove@lastbox@at@balancing{%
29 \unskip\unkern\unpenalty
30 \unskip\unkern\unpenalty
31 \unskip\unkern\unpenalty
32 {\setbox\z@\lastbox}%

```

```

33 \unskip\unkern\unpenalty
34 \unskip\unkern\unpenalty
35 \unskip\unkern\unpenalty
36 }

```

Macros used in debug mode.

```

37 \def\show@box#1{%
38   \bgroup
39   \showboxbreadth=20000\showboxdepth=20000%
40   \showbox#1\relax
41   \egroup
42 }
43 \def\wlog@balance@debug#1{\if@balance@debug \wlog{#1}\fi}
44 \def\log@box@info#1{<box\the#1>(\the\ht#1+\the\dp#1)x\the\wd#1}
45 \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.

```

46 \gdef\analyze@lastbox@box#1{%
47   \setbox\flushend@@varbox@a\vbox{%
48     \unvbox#1%
49     \global\flushend@@lastskip@a\lastskip
50     \unskip
51     \global\var@@temp@a\lastkern
52     \unkern
53     \global\flushend@@penalty@a\lastpenalty
54     \unpenalty
55     \ifdim\lastskip>\z@
56       \global\flushend@@lastskip@a\lastskip
57     \fi
58     \unskip
59     \ifdim\lastkern>\z@
60       \global\var@@temp@a\lastkern
61     \fi
62     \unkern
63     \ifnum\lastpenalty>\z@
64       \global\flushend@@penalty@a\lastpenalty
65     \fi
66     \unpenalty
67     \global\setbox\flushend@@tempbox@a\lastbox
68   }%
69   \wlog@balance@debug{^^J::analyze@lastbox@box::\log@box@info{#1}%
70     ^^J::unvbox: \log@box@info{\flushend@@varbox@a}%
71     ^^J::lastbox: \log@box@info{\flushend@@tempbox@a}%
72     ^^J::lastskip: \the\flushend@@lastskip@a;
73     lastkern: \the\var@@temp@a;
74     lastpenalty: \the\flushend@@penalty@a
75   }%
76 }

```

```

\analyze@leftcolumn@box  {\box}
77 \gdef\analyze@leftcolumn@box#1{%
78   \splittopskip\z@ \vfuzz\maxdimen \vbadness\maxdimen
79   \flushend@@lastskip@b\ht#1%
80   \wlog@balance@debug{^^Jmainbox: \log@box@info{#1}}%
81   \setbox\flushend@@varbox@a\vbox{%
82     \unvbox#1%
83     \global\flushend@@lastskip@a\lastskip
84     \unskip
85     \global\flushend@@lastkern@a\lastkern
86     \unkern
87     \global\flushend@@penalty@a\lastpenalty
88     \unpenalty
89     \global\setbox\flushend@@tempbox@a\lastbox
90   }%
91   \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
92   \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@a
93   \wlog@balance@debug{.-box: \log@box@info{\flushend@@varbox@a}%
94     ^^J.-lastbox: \log@box@info{\flushend@@tempbox@a}%
95     ^^J.-lastskip: \the\flushend@@lastskip@a;
96     lastkern: \the\flushend@@lastkern@a;
97     lastpenalty: \the\flushend@@penalty@a
98     ^^J.-diff: \the\flushend@@lastskip@b
99   }%
100   \check@@footnoterule@@box\flushend@@tempbox@a\flushend@@lastskip@b\flushend@@varbox@a
101   \check@@baselineskip@@skip\flushend@@lastskip@a\flushend@@lastskip@b\flushend@@lastskip@c
102   \ifvoid\flushend@@tempbox@a
103     \ifdim\ht\flushend@@varbox@a>\topskip
104       \flushend@@lastskip@b\ht\flushend@@varbox@a
105       \var@@temp@a\ht\flushend@@varbox@a
106       \loop
107         \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
108         \ifvoid\flushend@@varbox@a
109           \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
110           \advance \var@@temp@a -3\p@
111         \else
112           \var@@temp@a=-1\p@
113         \fi
114       \ifdim \var@@temp@a>\z@
115       \repeat
116       \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@varbox@a}%
117       \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
118       \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
119       \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
120       \wlog@balance@debug{.--box: \log@box@info{\flushend@@tempbox@c}%
121         ^^J.--lastbox: \log@box@info{\flushend@@varbox@a}%
122         ^^J.--diff: \the\flushend@@lastskip@b}%
123       \check@@footnoterule@@box\flushend@@varbox@a\flushend@@lastskip@b
124       \flushend@@tempbox@c

```

```

125         \check@@baselineskip@@skip\flushend@@lastskip@a\flushend@@lastskip@b
126         \flushend@@lastskip@c
127         \ifdim\ht\flushend@@varbox@a>.5\topskip
128         \analyze@lastbox@box\flushend@@varbox@a
129         \fi
130         \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
131     \else
132         \wlog@balance@debug{lastbox: \log@box@info{\flushend@@varbox@a}}%
133     \fi
134 \fi
135 \ifdim\ht\flushend@@varbox@a>\topskip
136     \expandafter\analyze@leftcolumn@box\expandafter\flushend@@varbox@a
137 \fi
138 }

```

\get@@footnoterule@@box

```

139 \def\get@@footnoterule@@box{%
140     \splittopskip\z@ \vfuzz\maxdimen \vbadness\maxdimen
141     \setbox\flushend@@varbox@a\vbox{\strut
142         \vskip\z@
143         \footnoterule
144         \unskip\unkern\unpenalty
145         \unskip\unkern\unpenalty
146     }%
147     \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\ht\strutbox
148     \xdef\footnoterule@@box@@ht{\the\ht\flushend@@varbox@a}%
149     \xdef\footnoterule@@box@@dp{\the\dp\flushend@@varbox@a}%
150     \xdef\footnoterule@@box@@wd{\the\wd\flushend@@varbox@a}%
151     \wlog@balance@debug{:footnoterule: \log@box@info{\flushend@@varbox@a}}%
152 }

```

\check@@footnoterule@@box  $\{\langle box \rangle\}\{\langle skip \rangle\}\{\langle box \rangle\}$

```

153 \def\check@@footnoterule@@box#1#2#3{%
154     \ifdim\ht#1=\footnoterule@@box@@ht
155     \ifdim\dp#1=\footnoterule@@box@@dp
156     \ifdim\wd#1=\footnoterule@@box@@wd
157         \ifdim#2>\topskip
158             \xdef\main@box@height{\the\ht#3}%
159             \xdef\main@box@skip{\the#2}%
160         \fi
161     \fi
162 \fi
163 \fi
164 }

```

\check@@baselineskip@@skip  $\{\langle dimension \rangle\}\{\langle dimension \rangle\}\{\langle var \rangle\}$

```

165 \def\check@@baselineskip@@skip#1#2#3{%
166     \ifdim#1>\z@
167         \ifdim#2>\z@

```

```

168         \global#3=\the#1%
169         \gdef\check@baselineskip@skip##1##2##3{%
170     \fi
171 \fi
172 }

\analyze@rightcolumn@box {(\box)}

173 \def\analyze@rightcolumn@box#1{%
174     \bgroup
175     \xdef\top@@floatbox@ht{\z@}%
176     \xdef\top@@floatbox@skip{\z@}%
177     \xdef\top@@section@skip{\z@}%
178     \splittopskip\z@ \vfuzz\maxdimen \vbadness\maxdimen
179     \wlog@balance@debug{^~J(R)mainbox: \log@box@info{#1}}%
180     \var@@temp@a3\p@
181     \setbox\flushend@@varbox@a\vbox{\strut
182         \vskip\z@
183         \unvcopy#1%
184     }%
185     \splittopskip\z@
186     \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\ht\strutbox
187     \flushend@@lastskip@a\ht\flushend@@varbox@a
188     \loop
189         \flushend@@lastskip@b\ht\flushend@@varbox@a
190         \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
191         \ifvoid\flushend@@tempbox@c
192             \advance \var@@temp@a 3\p@
193             \ifdim\var@@temp@a>\flushend@@lastskip@b
194                 \var@@temp@a=-1\p@
195             \fi
196         \else
197             \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
198             \ifdim\ht\flushend@@tempbox@c>\top@@floatbox@min
199                 \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
200                 \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
201                 \xdef\top@@floatbox@skip{\the\flushend@@lastskip@b}%
202                 \flushend@@lastskip@b\flushend@@lastskip@a
203                 \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
204                 \advance\flushend@@lastskip@b -\top@@floatbox@skip
205                 \xdef\top@@floatbox@ht{\the\flushend@@lastskip@b}%
206                 \var@@temp@a=3\p@
207             \else
208                 \advance\flushend@@lastskip@b -\ht\flushend@@tempbox@c
209                 \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
210                 \ifdim\ht\flushend@@tempbox@c>\topskip
211                     \else
212                         \xdef\top@@section@skip{\the\flushend@@lastskip@b}%
213                     \fi
214                 \var@@temp@a=-1\p@
215             \fi

```

```

216         \fi
217     \ifdim \var@@temp@a>\z@
218     \repeat
219     \ifvoid\flushend@@tempbox@c
220     \else
221         \ifdim\top@@section@skip>\z@
222         \else
223             \ifdim\ht\flushend@@tempbox@c>\z@
224                 \setbox\flushend@@varbox@a\vbox{\unvbox\flushend@@tempbox@c}%
225             \fi
226             \flushend@@lastskip@b\ht\flushend@@varbox@a
227             \var@@temp@a=3\p@
228             \loop
229                 \setbox\flushend@@tempbox@c\vsplit\flushend@@varbox@a to\var@@temp@a
230             \ifvoid\flushend@@tempbox@c
231                 \advance \var@@temp@a 3\p@
232                 \ifdim\var@@temp@a>\flushend@@lastskip@b
233                     \var@@temp@a=-1\p@
234                 \fi
235             \else
236                 \ifdim\ht\flushend@@tempbox@c>\z@
237                     \var@@temp@a=-1\p@
238                 \fi
239             \fi
240     \ifdim \var@@temp@a>\z@
241     \repeat
242     \loop
243         \setbox\flushend@@varbox@a\vbox{%
244             \unvbox\flushend@@tempbox@c
245             \unskip\unkern\unpenalty
246             \unskip\unkern\unpenalty
247             \unskip\unkern\unpenalty
248             \setbox\flushend@@tempbox@c\lastbox
249         }%
250     \flushend@@lastskip@b\ht\flushend@@varbox@a
251     \setbox\flushend@@varbox@a\vbox{%
252         \unvbox\flushend@@varbox@a
253         \unskip\unkern\unpenalty
254         \unskip\unkern\unpenalty
255         \unskip\unkern\unpenalty
256     }%
257     \advance\flushend@@lastskip@b -\ht\flushend@@varbox@a
258     \ifdim\flushend@@lastskip@b>\topskip
259         \xdef\top@@section@skip{\the\flushend@@lastskip@b}%
260     \fi
261     \ifdim\ht\flushend@@varbox@a>2\topskip
262         \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@varbox@a}%
263     \repeat
264 \fi
265 \fi

```

```

266 \egroup
267 }

```

\last@outputdblcol Columns balancing of the twocolumn mode page.

```

268 \def\last@outputdblcol{%
269   \if@firstcolumn
270     \global \@firstcolumnfalse
271     \global \setbox\@leftcolumn \box\@outputbox
272   \else
273     \global \@firstcolumntrue
274     \@tempdima\ht\@leftcolumn
275     \splittopskip\topskip \splitmaxdepth\maxdepth
276     \var@@temp@spread=\wd\@outputbox
277     \if@auto@baselineskip
278       %% Trying guess baselineskip value on column break
279       \get@@footnoterule@@box
280       \xdef\main@box@height{\the\ht\@leftcolumn}%
281       \xdef\main@box@skip{\z@}%
282       \global\flushend@@lastskip@c\z@
283       \setbox\flushend@@varbox@a\vbox{\unvcopy\@leftcolumn}%
284       \analyze@leftcolumn@box\flushend@@varbox@a
285       \setbox\flushend@@varbox@a\vbox{\unvcopy\@outputbox}%
286       \analyze@rightcolumn@box\flushend@@varbox@a
287       \ifdim\main@box@skip>\z@
288         \splittopskip\z@
289         \setbox\flushend@@varbox@a\vsplit\@leftcolumn to\main@box@height
290       \else
291         \setbox\flushend@@varbox@a\box\@leftcolumn
292       \fi
293       \ifdim\var@@temp@spread>\z@
294         \setbox\@outputbox\vbox{\strut
295           \vskip\z@
296           \unvbox\@outputbox
297         }%
298         \splittopskip\z@
299         \setbox\flushend@@tempbox@c\vsplit\@outputbox to\ht\strutbox
300         \ifdim\top@@floatbox@skip>\z@
301           \setbox\flushend@@tempbox@c\vsplit\@outputbox to\top@@floatbox@ht
302           \setbox\flushend@@tempbox@c\vbox{\unvbox\flushend@@tempbox@c}%
303         \fi
304         \setbox\@tempboxa\vbox{%
305           \unvbox\flushend@@varbox@a
306           \unskip\unkern\unpenalty
307           \vskip\flushend@@lastskip@c
308           \the\atColsBreak
309           \hrule\@height\flushend@@page@rule width\columnwidth
310           \ifdim\top@@section@skip>\topskip
311             \vskip\top@@section@skip
312           \fi
313           \unvbox\@outputbox

```

```

314         \remove@lastbox@at@balancing
315         \the\atColsEnd
316     }%
317     \ifdim\top@@floatbox@skip>\z@
318         \setbox\@outputbox\vbox{\unvbox\flushend@@tempbox@c}%
319     \fi
320 \else %% rightcolumn empty
321     \setbox\@tempboxa\vbox{%
322         \unvbox\flushend@@varbox@a
323         \remove@lastbox@at@balancing
324         \the\atColsEnd
325     }%
326 \fi
327 \else
328     %% Ignore baselineskip value on column break
329     \ifdim\var@@temp@spread>\z@
330         \setbox\@outputbox\vbox{\strut
331             \vskip\z@
332             \unvbox\@outputbox
333         }%
334         \splittopskip\z@
335         \setbox\flushend@@tempbox@c\vsplit\@outputbox to\ht\strutbox
336         \setbox\@tempboxa\vbox{%
337             \unvbox\@leftcolumn
338             \setbox\z@\lastbox
339             \unskip\unkern\unpenalty
340             \the\atColsBreak
341             \hrule\@height\flushend@@page@rule width\columnwidth
342             \unvbox\@outputbox
343             \remove@lastbox@at@balancing
344             \the\atColsEnd
345         }%
346     \else
347         \setbox\@tempboxa\vbox{%
348             \unvbox\@leftcolumn
349             \remove@lastbox@at@balancing
350             \the\atColsEnd
351         }%
352     \fi
353 \fi
354 \ifdim\main@box@skip>\z@
355     \@tempdimb\ht\@tempboxa
356     \advance\@tempdimb -\main@box@skip
357     \advance\@tempdimb -\ht\@leftcolumn
358     \@tempdimb .5\@tempdimb
359     \splittopskip\topskip \splitmaxdepth\maxdepth
360 \loop
361     \setbox\flushend@@varbox@a\copy\@tempboxa
362     \setbox\flushend@@tempbox@a\vsplit\flushend@@varbox@a to\@tempdimb
363     \setbox\flushend@@tempbox@c\vbox{%

```

```

364         \unvcopy\flushend@@tempbox@a
365         \vskip\main@box@skip
366         \unvcopy\@leftcolumn
367     }%
368     \setbox\flushend@@varbox@c\vbox{\unvbox\flushend@@varbox@a}%
369     \var@@temp@spread=\ht\flushend@@tempbox@c
370     \advance\var@@temp@spread by-\ht\flushend@@varbox@c
371     \wlog@balance@debug{Left x: \the\ht\flushend@@tempbox@a
372         +\the\dp\flushend@@tempbox@a=\the\ht\flushend@@varbox@a
373         +\the\dp\flushend@@varbox@a::\the\@tempdimb
374     ^^JLeft 0: \the\ht\flushend@@tempbox@c
375         +\the\dp\flushend@@tempbox@c::\the\@tempdimb
376     ^^JRight x: \the\ht\flushend@@varbox@c
377         +\the\dp\flushend@@varbox@c=\the\ht\flushend@@varbox@a
378         +\the\dp\flushend@@varbox@a::\the\@tempdimb
379     ^^JExtra height:\the\var@@temp@spread\space when \the\@tempdimb
380 }%
381 \ifdim\var@@temp@spread<\z@ \advance\@tempdimb 1\p@ \repeat
382 \flushend@@lastskip@a\the\ht\flushend@@tempbox@c
383 \flushend@@lastskip@b\the\@tempdimb
384 \setbox\flushend@@tempbox@a\vsplit\@tempboxa to\@tempdimb
385 \setbox\@leftcolumn\vbox to\@tempdima{%
386     \vbox to \flushend@@lastskip@a{%
387         \unvbox\flushend@@tempbox@a
388         \vskip\main@box@skip
389         \unvbox\@leftcolumn
390         \vss
391     }%
392     \hrule\@height\flushend@@page@rule width\textwidth
393     \vss
394 }%
395 \global\ht\@leftcolumn=\the\@tempdima
396 \wlog{- LAST -}%
397     ^^JExtra skip:\the\var@@temp@spread
398     ^^JLeft:\the\ht\@leftcolumn/\the\dp\@leftcolumn
399     ^^JRight:\the\ht\@tempboxa/\the\dp\@tempboxa
400     ^^JOutput:\the\@tempdimb
401 }%
402 \setbox\@outputbox\vbox to\@tempdima{%
403     \vbox spread\var@@temp@spread{\unvbox\@tempboxa}%
404     \vss
405 }%
406 \else
407     \@tempdimb \ht\@tempboxa
408     \ifdim\top@@floatbox@skip>\z@
409         \advance\@tempdimb \top@@floatbox@skip
410         \advance\@tempdimb \top@@floatbox@ht
411     \fi
412     \@tempdimb .5\@tempdimb
413     \splittopskip\topskip \splitmaxdepth\maxdepth

```

```

414 \loop
415 \setbox\flushend@@varbox@a\copy\@tempboxa
416 \setbox\flushend@@tempbox@a\vsplit\flushend@@varbox@a to\@tempdimb
417 \setbox\flushend@@tempbox@c\ vbox{\unvcopy\flushend@@tempbox@a}%
418 \ifdim\top@@floatbox@skip>\z@
419 \setbox\flushend@@varbox@c\ vbox{%
420 \unvcopy\@outputbox
421 \vskip\top@@floatbox@skip
422 \unvbox\flushend@@varbox@a
423 }%
424 \else
425 \setbox\flushend@@varbox@c\ vbox{\unvbox\flushend@@varbox@a}%
426 \fi
427 \var@@temp@spread=\ht\flushend@@tempbox@c
428 \advance\var@@temp@spread by-\ht\flushend@@varbox@c
429 \wlog@balance@debug{Left x: \the\ht\flushend@@tempbox@a
430 +\the\dp\flushend@@tempbox@a=\the\ht\flushend@@varbox@a
431 +\the\dp\flushend@@varbox@a::\the\@tempdimb
432 ^^JLeft 0: \the\ht\flushend@@tempbox@c
433 +\the\dp\flushend@@tempbox@c::\the\@tempdimb
434 ^^JRight x: \the\ht\flushend@@varbox@c
435 +\the\dp\flushend@@varbox@c=\the\ht\flushend@@varbox@a
436 +\the\dp\flushend@@varbox@a::\the\@tempdimb
437 ^^JExtra height:\the\var@@temp@spread\space when \the\@tempdimb
438 }%
439 \ifdim\var@@temp@spread<\z@ \advance\@tempdimb 1\p@ \repeat
440 \@tempdimb\ht\flushend@@tempbox@c
441 \wlog{- LAST -}%
442 ^^JExtra skip:\the\var@@temp@spread
443 ^^JLeft:\the\ht\flushend@@tempbox@c/\the\dp\flushend@@tempbox@c
444 ^^JRight:\the\ht\flushend@@varbox@c/\the\dp\flushend@@varbox@c
445 ^^JOutput:\the\@tempdimb
446 }%
447 \setbox\flushend@@tempbox@c\vsplit\@tempboxa to\@tempdimb
448 \setbox\flushend@@varbox@c\ vbox{\unvbox\flushend@@tempbox@a}%
449 \setbox\@leftcolumn\ vbox to\@tempdima{%
450 \vbox to\@tempdimb{\unvbox\flushend@@varbox@c\vss}%
451 \hrule\@height\flushend@@page@rule width\textwidth
452 \vss
453 }%
454 \global\ht\@leftcolumn=\the\@tempdima
455 \ifdim\top@@floatbox@skip>\z@
456 \setbox\@outputbox\ vbox to\@tempdima{%
457 \vbox spread\var@@temp@spread{%
458 \unvbox\@outputbox
459 \vskip\top@@floatbox@skip
460 \unvbox\@tempboxa
461 }%
462 \vss
463 }%

```

```

464         \else
465             \setbox\@outputbox\ vbox to\@tempdima{%
466                 \vbox spread\var@@temp@spread{\unvbox\@tempboxa}%
467                 \vss
468             }%
469         \fi
470     \fi
471     \setbox\@outputbox \vbox {%
472         \hb@xt@\textwidth {%
473             \hb@xt@\columnwidth {%
474                 \fmt@box@adds{\box\@leftcolumn}\hss}%
475             \hfil
476             \vrule \@width\columnseprule
477             \hfil
478             \hb@xt@\columnwidth {%
479                 \fmt@box@adds{\box\@outputbox}\hss}%
480             }%
481         }%
482     \global\let\@outputdblcol\saved@orig@@outputdblcol
483     \global\atColsEnd}%
484     \ifvoid\hold@viper
485     \else
486         \setbox\@outputbox\vbox{\box\hold@viper\box\@outputbox}%
487     \fi
488     \@combinedblfloats
489     \@outputpage
490     \begingroup
491         \@dblfloatplacement
492         \@startdblcolumn
493         \@whiles\if@fcolmade\fi
494             {\@outputpage\@startdblcolumn}%
495         \ifvoid\@viper
496         \else
497             \global\setbox\@viper\vbox{%
498                 \vskip-\stripsep
499                 \unvbox\@viper
500             }%
501             \csname @viperoutput\endcsname
502         \fi
503     \endgroup
504 \fi
505 }

```

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

```

506 \usepackage{etoolbox}
507 \AtBeginDocument{%
508     \global\let\saved@orig@@outputdblcol\@outputdblcol
509     \global\let\balanced@@outputdblcol\last@outputdblcol
510     \preto\enddocument{\let\@outputdblcol\balanced@@outputdblcol}%
511     \appto\footnoterule{\vskip\z@}%

```

512 }

User interface commands for the balancing pages.

```
513 \def\flushcolsend{\global\let\@outputdblcol\last@outputdblcol}
514 \def\raggedcolsend{\global\let\@outputdblcol\saved@orig@@outputdblcol}
515 \def\flushend{\global\let\balanced@@outputdblcol\last@outputdblcol}
516 \def\raggedend{\global\let\balanced@@outputdblcol\saved@orig@@outputdblcol}

517 \if@balance@debug
518     \showcolsendrule
519 \fi
```