```
Series[(1 + h A1) (1 + (A1 + 2 A2) h), {h, 0, 1}]
```

$$1 + 2\ (A1 + A2)\ h + 0[h]^2$$

```
Series[(1 + h / 4 A1) / (1 - h / 4 A1), {h, 0, 2}]
```

$$1 + \frac{A1\ h}{2} + \frac{A1^2\ h^2}{8} + 0[h]^3$$

```
(* Crank Nicolson with Strang Symm *)

cn = Series[1 / (1 - h / 4 A1) ((1 + h / 4 A1) 1 / (1 - h / 2 A2)
        ((1 + h / 2 A2) 1 / (1 - h / 4 A1) ((1 + h / 4 A1) f3 + h / 2 b1) + h b2) + h / 2 b1), {h, 0, 3}]
```

$$f3 + (b1 + b2 + A1\ f3 + A2\ f3)\ h + \frac{1}{2}\ (A1\ b1 + A2\ b1 + A1\ b2 + A2\ b2 + A1^2\ f3 + 2\ A1\ A2\ f3 + A2^2\ f3)\ h^2 +$$
$$\frac{1}{16}\ (3\ A1^2\ b1 + 6\ A1\ A2\ b1 + 4\ A2^2\ b1 + 2\ A1^2\ b2 + 4\ A1\ A2\ b2 +$$
$$4\ A2^2\ b2 + 3\ A1^3\ f3 + 8\ A1^2\ A2\ f3 + 8\ A1\ A2^2\ f3 + 4\ A2^3\ f3)\ h^3 + 0[h]^4$$

```
ex = Series[Exp[h (A1 + A2)] (f3 + (b1 + b2) / (A1 + A2)) - (b1 + b2) / (A1 + A2), {h, 0, 3}]
```

$$f3 + (b1 + b2 + A1\ f3 + A2\ f3)\ h + \frac{1}{2}\ (A1 + A2)\ (b1 + b2 + A1\ f3 + A2\ f3)\ h^2 +$$
$$\frac{1}{6}\ (A1 + A2)^2\ (b1 + b2 + A1\ f3 + A2\ f3)\ h^3 + 0[h]^4$$

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Simplify[ex - cn]
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$$\frac{1}{48}\ (-A1^2\ (b1 - 2\ b2) - 2\ A1\ A2\ (b1 - 2\ b2) - A1^3\ f3 - 4\ A2^2\ (b1 + b2 + A2\ f3))\ h^3 + 0[h]^4$$