MODULE *CigaretteSmokers*

A specification of the cigarette smokers problem, originally described in 1971 by *Suhas Patil*.
https://*en.wikipedia.org*/wiki/*Cigarette_smokers_problem*

EXTENDS *Integers*, *FiniteSets*

CONSTANT *Ing*, *Offers*
VARIABLE *smokers*, *dealer*

'Ing' is a set of ingredients, originally {*matches*, *paper*, *tobacco*}
'Offers' is a subset of subsets of ingredients, each missing just one ingriedent

ASSUME $\land\ Offers \subseteq (\text{SUBSET } Ing)$
$\land\ \forall\, n \in Offers : Cardinality(n) = Cardinality(Ing) - 1$

'smokers' is a function from the ingredient the smoker has infinite supply of, to a BOOLEAN flag signifying smoker's state (smoking/not smoking) 'dealer' is an element of 'Offers', or an empty set

$TypeOK \triangleq \land\ smokers \in [Ing \to [smoking : \text{BOOLEAN }]]$
$\land\ dealer \in Offers \lor dealer = \{\}$

$vars \triangleq \langle smokers,\ dealer \rangle$

$Init \triangleq \land\ smokers = [r \in Ing \mapsto [smoking \mapsto \text{FALSE}]]$
$\land\ dealer \in Offers$

$startSmoking \triangleq \land\ dealer \neq \{\}$
$\land\ smokers' = [r \in Ing \mapsto [smoking \mapsto \{r\} \cup dealer = Ing]]$
$\land\ dealer' = \{\}$

$stopSmoking \triangleq \land\ dealer = \{\}$
$\land\ \text{LET } r \triangleq \text{CHOOSE } r \in Ing : smokers[r].smoking$
$\text{IN}\quad smokers' = [smokers \text{ EXCEPT } ![r].smoking = \text{FALSE}]$
$\land\ dealer' \in Offers$

$Next \triangleq startSmoking \lor stopSmoking$

$Spec \triangleq Init \land \Box[Next]_{vars}$
$FairSpec \triangleq Spec \land \text{WF}_{vars}(Next)$

An invariant checking that at most one smoker smokes at any particular moment

$AtMostOne \triangleq Cardinality(\{r \in Ing : smokers[r].smoking\}) \leq 1$