

**(12) United States Patent  
Philipp**

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- (54) **CHARGE TRANSFER CAPACITANCE MEASUREMENT CIRCUIT**
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- (\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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- (21) Appl. No.: **09/390,869**
- (22) Filed: **Sep. 7, 1999**

**Related U.S. Application Data**

- (60) Provisional application No. 60/109,889, filed on Nov. 25, 1998.
- (51) Int. Cl.<sup>7</sup> ..... **G01R 27/26**
- (52) U.S. Cl. .... **324/678; 324/658**
- (58) Field of Search ..... **324/678, 658, 324/661, 663, 665, 676, 679**

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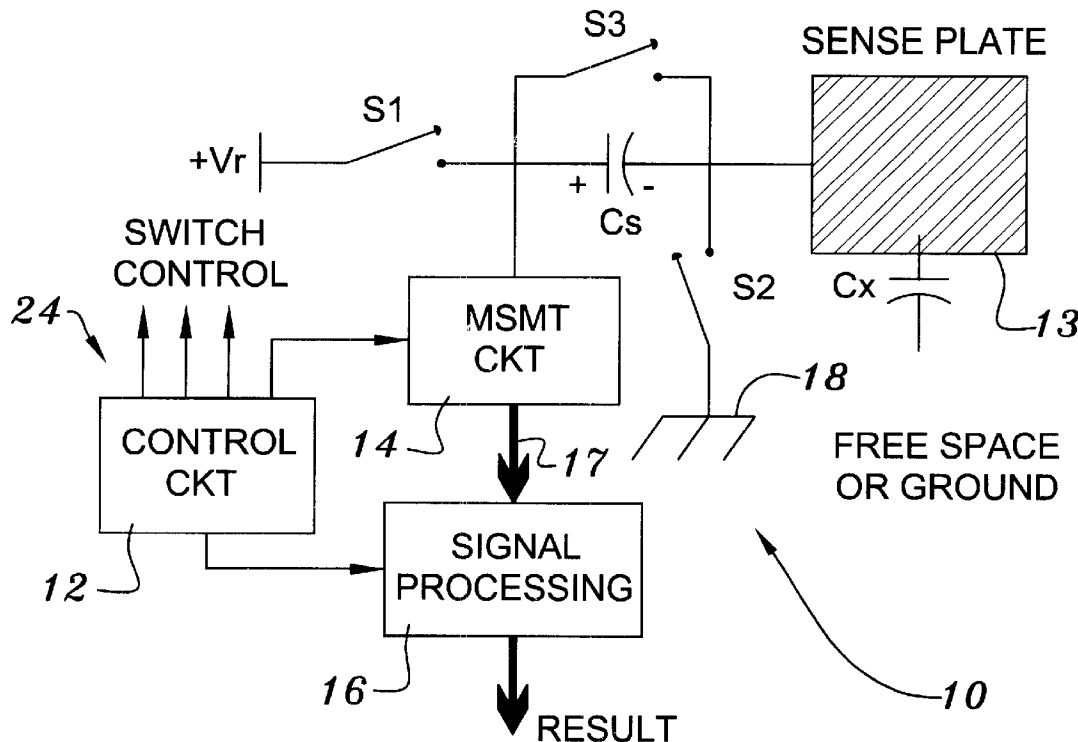
Assistant Examiner—T. R. Sundaram

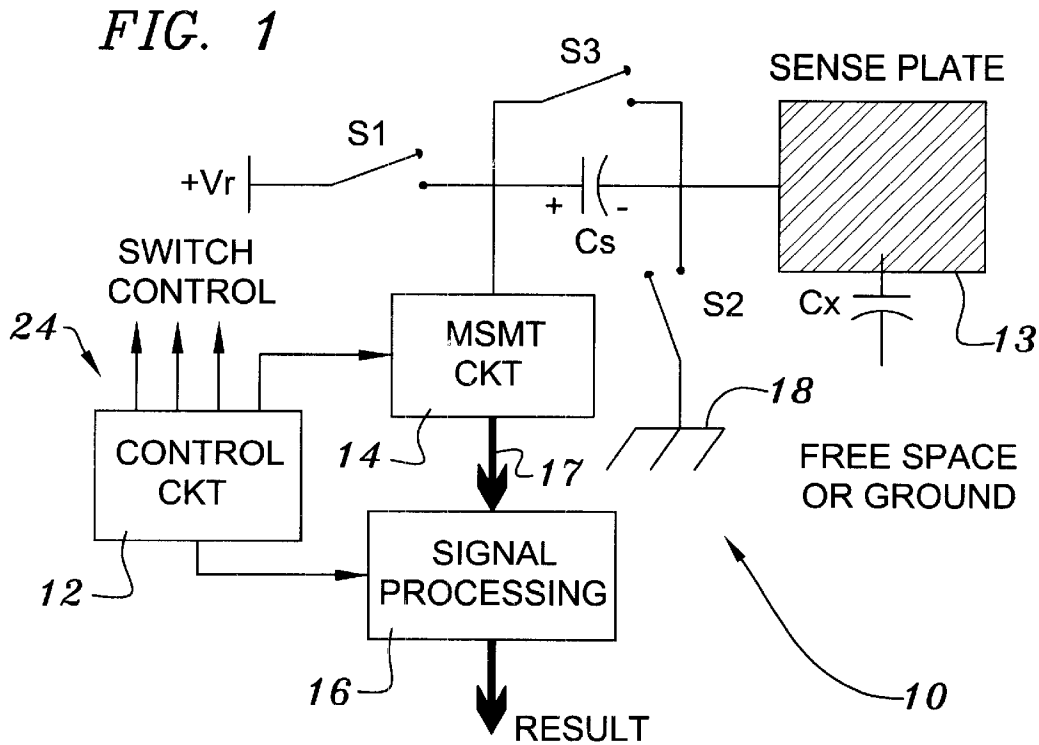
(74) Attorney, Agent, or Firm—David Kiewit

**(57) ABSTRACT**

Pulse circuits for measuring the capacitance to ground of a plate may be used in control equipment to provide an indication of the proximity of a person or object to be sensed. Pulse circuits are disclosed that are made from sets of three or more electrical switching elements arranged so that each of the switching elements has one side electrically connected to either a supply voltage or to an electrical ground. These arrangements are compatible with existing integrated circuit fabrication technology. In addition, the circuitry can be configured as a proximity sensing switch that requires only a two wire connection to a host apparatus.

**39 Claims, 14 Drawing Sheets**





	STEP	S1	S2	S3	FUNCTION
LOOP	A	-	X	X	RESET ALL
	B	-	-	-	DEADTIME
	C	X	-	-	CHARGE-TRANSFER
	D	-	-	-	DEADTIME
	E	-	X	-	HOLD
	F	-	X	-	MEASURE

**FIG. 2**

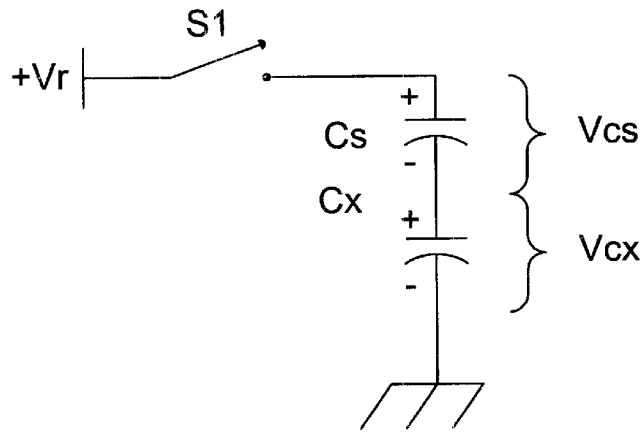


FIG. 3

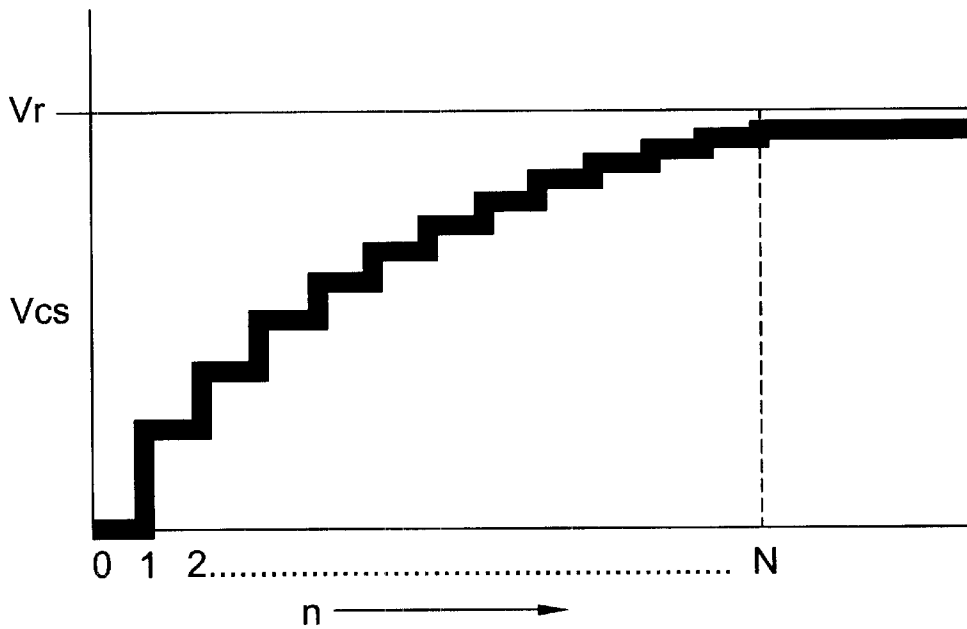
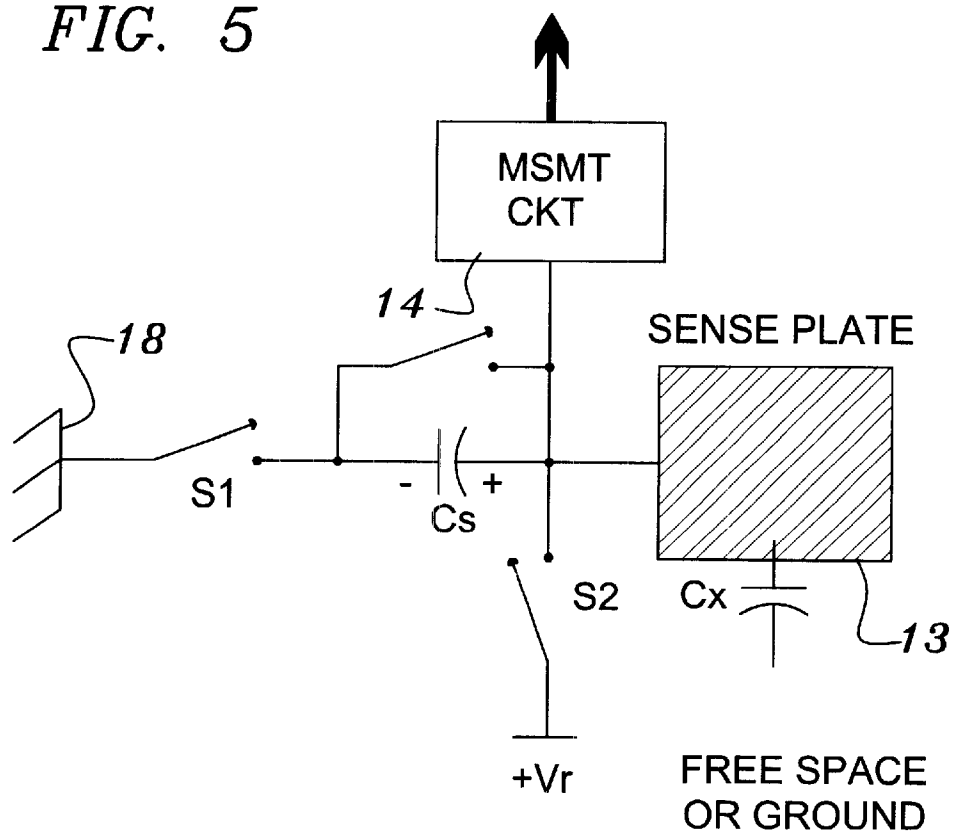


FIG. 4

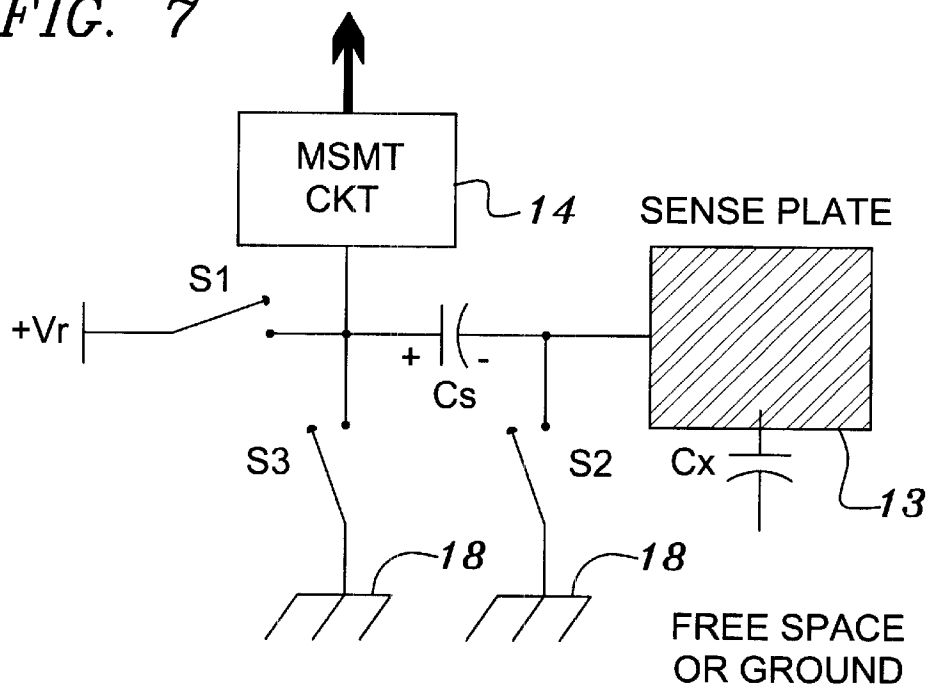
FIG. 5



	STEP	S1	S2	S3	FUNCTION
	A	X	-	X	RESET ALL
LOOP	B	-	-	-	DEADTIME
	C	-	X	-	CHARGE
	D	-	-	-	DEADTIME
	E	X	-	-	TRANSFER
	F	X	-	-	MEASURE

FIG. 6

FIG. 7



	STEP	S1	S2	S3	FUNCTION
LOOP	A	-	X	X	RESET ALL
	B	-	-	-	DEADTIME
	C	X	-	-	CHARGE-TRANSFER
	D	-	-	-	DEADTIME
	E	-	X	-	HOLD
	F	-	X	-	MEASURE (HOLD)

FIG. 8

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